



NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

**EFFECTIVENESS OF VOLUNTARY EDUCATION IN
OPERATIONAL ENVIRONMENTS: AN ANALYSIS OF
THE NAVY COLLEGE PROGRAM FOR AFLOAT
COLLEGE EDUCATION (NCPACE)**

by

Seryoung C. Park

March 2011

Thesis Advisor:
Second Reader:

Samuel E. Buttrey
Elda Pema

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AFLOAT COLLEGE EDUCATION (NCPACE)**

Seryoung C. Park
Civilian, Department of Defense
B.A., University of California at Berkeley, 2004

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March 2011**

Author: Seryoung C. Park

Approved by: Samuel E. Buttrey
Thesis Advisor

Elda Pema
Second Reader

Robert F. Dell
Chairman, Department of Operations Research

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ABSTRACT

The Navy College Program for Afloat College Education (NCPACE) is one of the main components of the United States Navy's Voluntary Education (VOLED) program, offering college courses and remedial academic skill modules to sailors on sea duty or stationed in remote locations.

This thesis predicts the likelihood of NCPACE course completion by course and individual participant characteristics using a logistic regression model. We found that participants who take distance learning-based and mathematics courses have lower predicted odds of succeeding, while participants with higher Armed Forces Qualification Test (AFQT) scores and levels of education have higher predicted odds of succeeding. Some variation was noticed between unit vessel types and school.

This thesis also evaluates the likelihood of attempting and successfully completing a subsequent course conditional on the outcome of the first course. Successful completion of the first course is positively associated with an enrollment in a subsequent course in addition to the successfully completion of that course.

Lastly, this thesis examines promotion, extension and reenlistment outcomes for first-term NCPACE participants with 48-month contracts. We found that those who successfully completed at least one course are predicted to be more likely to promote to E5 and are predicted to be slightly less likely to reenlist in the Navy.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACES	Army Continuing Education System
AFQT	Armed Forces Qualification Test
AUC	Area under the [ROC] curve
CMF	Career Management Field
DMDC	Defense Manpower Data Center
DoD	Department of Defense
EDMIS	Educational Management Information System
FAST	Functional Academic Skills Training
FY	Fiscal Year
MOSIT	Military Occupation Specialty Improvement Training
NAVADMIN	Navy administrative message
NCMIS	Navy Campus Management Information System
NCO	Non-commissioned officer
(NC)PACE	(Navy College) Program for Afloat College
NVR	Naval Vessel Register
ROC	Receiver Operating Characteristic
TA	Tuition Assistance
UIC	Unit Identification Code
VOLED	Voluntary Education

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EXECUTIVE SUMMARY

Department of Defense (DoD) Directive 1322.08E states that it is DoD policy to establish and maintain voluntary education (VOLED) programs that are available to all active duty personnel, regardless of duty location. VOLED programs are defined as continuing, adult, or postsecondary education programs that service members elect to participate in during their off-duty time and are directed to provide educational opportunities comparable to those that are available to civilians.

The Navy College Program for Afloat College Education (NCPACE) is one of the main components of the United States Navy's VOLED program. NCPACE offers college courses and remedial academic skill modules to sailors on sea duty. These courses are delivered through electronic methods (Technology PACE) or traditional classroom instruction (Instructor PACE). Courses are tuition-free, and sailors pay only costs associated with college coursework educational materials. All undergraduate courses are from institutions affiliated with the Service members Opportunity College degree program for the Navy, ensuring sailors the opportunity to transfer credits and complete degrees.

A recent study indicates a significant rise in the number and percentage of sailors enrolling in distance education courses through the Navy's Tuition Assistance (TA) program between 1995 and 2008. This growth in distance education enrollments has been attributed to the increase in operational tempo since September 2001. Distance learning course completion rates are reported as lagging behind traditional course completion rates for all years considered, with Physical Science courses experiencing the biggest differences in completion rates between instruction methods (Woosely, 2009).

Though the study referenced above makes an inferential connection between distance learning and operational tempo events, it and other evaluations of military-sponsored continuing education programs done in the past do not directly address how students perform academically in operational environments. This thesis attempts to fill this gap by evaluating the effectiveness of the NCPACE component of VOLED.

NCPACE is a good candidate for addressing the effectiveness of distance education and academic success in operational environments in general, as the program's students are all on sea duty and the program has a distance education component. Identifying the factors associated with successful NCPACE course completions provides information necessary to make VOLED programs more effective as a whole.

This thesis predicts the likelihood of NCPACE course completions by course and individual participant characteristics using a logistic regression model. We found that participants who take distance learning-based and mathematics courses have lower predicted odds of succeeding, while higher Armed Forces Qualification Test (AFQT) scores and levels of education resulted in higher predicted odds of succeeding. Some variation was noticed between unit vessel types and school.

This thesis also evaluates the likelihood of attempting and successfully completing a subsequent course with a consideration given to the outcome of the first course. Successful completion of the first course is positively associated with enrollments in subsequent courses and in successfully completing subsequent ones.

Lastly, this thesis examines promotion, extension and reenlistment outcomes for first-term NCPACE participants with 48-month contracts. We found that those who successfully completed at least one course are predicted to be more likely to promote to E5 and are predicted to be slightly less likely to reenlist in the Navy.

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I. INTRODUCTION

A. BACKGROUND

Department of Defense (DoD) Directive 1322.08E states that it is DoD policy to establish and maintain voluntary education (VOLED) programs that are available to all active duty personnel, regardless of duty location. VOLED programs are defined as continuing, adult, or postsecondary education programs that service members elect to participate in during their off-duty time and which are directed to provide educational opportunities comparable to those that are available to civilians.

The Navy College Program for Afloat College Education (NCPACE) is one of the main components of the United States Navy's VOLED program. NCPACE offers college courses and remedial academic skill modules to sailors on sea duty or in designated geographically isolated installations. What makes this program important is that it is specifically geared towards Service members who would otherwise have difficulty gaining access to continuing education resources due to their physical location and less-than-predictable work schedules. These courses are delivered through electronic methods (Technology PACE) or traditional classroom instruction (Instructor PACE). Courses are tuition-free, and sailors pay only the costs associated with college coursework educational materials. All undergraduate courses are from institutions that are accredited by an accrediting body recognized by the Department of Education and affiliated with the Servicemembers Opportunity College degree program for the Navy, ensuring sailors the opportunity to transfer credits and complete degrees (OPNAVINST 1560.9A, 2008).

Over time, numerous Navy administrative messages (NAVADMINs) have emphasized the importance of an educated Navy force, highlighted the Navy's commitment to providing educational opportunities for sailors, and stressed the difficulty of successfully completing courses and degrees alongside performing official Navy duties. This is well illustrated by the Navy's decision in 2005 to require an associate's

degree for E8 selection in fiscal year 2011 and its subsequent decision to rescind this requirement in 2007 (NAVADMIN 203/05, 2005; NAVADMIN 150/07, 2007).

Several of these messages specifically addressed changes to NCPACE policies and guidelines. In May 2004, NAVADMIN 109/04 announced an interim NCPACE policy that aimed to make the program more cost-effective and yield higher success rates among participants. The policy announced that participants were required to receive written approval from their commands and limited enrollment to two courses per term, with first time Technology PACE students limited to one course. The message stipulated minimum course enrollment levels, stipulated ratios of computers to students, and called for command leadership to play a more active role in ensuring NCPACE successes.

In June 2007, NAVADMIN 161/07 announced additional provisions for sailors enrolling in NCPACE courses. This message stated that participants were required to have passed their most recent advancement exam (or have approval from their commanding officer), disallowed enlisted members with fewer than twenty years of service who had less than one year remaining on their agreement, and required education plans for sailors who have completed their fifth course.

In February 2008, NAVADMIN 042/08 rescinded the restriction for enlisted sailors with less than one year of service left and reiterated guidelines for command involvement and the requirement for sailors who have taken more than five courses to commit to their education plan. It placed additional restrictions against taking courses towards degrees already earned, with exceptions granted for sailors who change their designator or rating.

In March 2010, NAVADMIN 105/10 added additional requirements for NCPACE participants and reemphasized command leadership involvement. It required the aforementioned individual education plan for all enrollees, regardless of number of classes completed, and restricted enrollment to classes that lead to a degree. A prerequisite of completing one year at the first permanent duty station before seeking approval for NCPACE courses was added. It directly addressed the issue of course

completions by calling for those having trouble with their coursework to talk to their academic advisors and command leaders before dropping a course.

A recent study indicates a significant rise in the number and percentage of sailors enrolling in distance education courses through the Navy's Tuition Assistance (TA) program between 1995 and 2008. This growth in distance education enrollments has been attributed to the increase in operational tempo since September 2001. Distance learning course completion rates are reported as lagging behind traditional course completion rates for all years considered, with Physical Science courses experiencing the biggest differences in completion rates between instruction methods (Woosely, 2009).

Though the study referenced above makes an inferential connection between distance learning and operational tempo events, it and other evaluations of military-sponsored continuing education programs done in the past do not directly address how students perform academically in operational environments. This thesis attempts to fill that gap by evaluating the effectiveness of the NCPACE component of VOLED. NCPACE is a good candidate for addressing the effectiveness of distance education and academic success in operational environments in general, as the program's students are all on sea duty and the program has a distance education component. Identifying the factors associated with successful NCPACE course completions will provide the information needed to make VOLED programs more effective as a whole.

B. OBJECTIVES

The primary objective of this thesis is to determine factors associated with successful NCPACE course completions. Both participant and course characteristics will be evaluated. It will also attempt to quantify the impact a failed course has on the sailor's desire to take additional college courses and factor changes made to NCPACE policies and guidelines over time. This thesis characterizes what leads to a sailor's ability to succeed in continuing education programs in operational environments and to serve as an aid in screening and counseling VOLED participants. This thesis also looks for trends in program participation rates and passing rates over time. The course completion analysis will be done at the sailor level with respect to the first course taken.

The secondary objective of this thesis is to determine if the outcomes of NCPACE courses have an effect on promotion and retention.

1. Literature Review

a. Garcia and Joy (1998)

Prior analyses of DoD VOLED programs focused on Tuition Assistance (TA) programs and were primarily concerned with how TA usage impacted promotion and retention. Garcia and Joy (1998) published one of the few studies that specifically identified factors associated with succeeding in NCPACE in addition to addressing the effectiveness of Navy VOLED as a whole. Their model distinguished the following sailor and course characteristics as factors that caused significant differences in NCPACE college level course completion rates:

- Higher-ranked sailors had higher completion rates: 71 percent of courses taken by E1 and E2s were successfully completed, whereas 81 percent of courses taken by E3 through E9s were successfully completed.
- Instructor-based classes had higher completion rates: courses taken through Technology PACE had a lower completion rate than those taken through Instructor PACE (77 percent of Technology-based classes were successfully completed versus 84 percent of Instructor-based classes).
- Mathematics classes had lower completion rates: 67 percent of mathematics classes were successfully completed, while 81 percent of non-mathematics classes were successfully completed.
- First attempts are more successful than second attempts: 80 percent of first courses were successfully completed, whereas only 67 percent of second courses were successfully completed.

- Submariners had higher completion rates: completion rates aboard submarines were at least 10 percentage points higher than completion rates aboard other ship types.
- Orientation participation, AFQT score, and previous college experience were also associated as factors that affected completion rates.
- For lower division courses, NCPACE success rates were lower than success rates associated with TA: Garcia and Joy (1998) hypothesized that completion rates were lower for NCPACE courses because TA users were required to pay back any assistance used towards a failed course and were typically in less demanding work environments.

These completion rate estimates were based on NCPACE course data dating between July 1995 and May 1996. Garcia and Joy (1998) did the regression analysis in two stages to correct for a potential selection bias that may exist between Instructor PACE and Technology PACE courses, as Technology courses have characteristics that may make them more demanding. The first regression modeled the probability of receiving instruction electronically. The second regression modeled the probability of successfully completing a PACE course using a correction factor derived from the first model.

Both the promotion and retention regression models were estimated in two stages in the same manner as the NCPACE model. This was done to correct selection biases in which may exist as a result of VOLED participants having higher than average motivation. The first stage modeled VOLED participation using involvement in academic counseling as an instrumental variable. This was used to calculate a correction factor for the promotion and retention models. Other variables considered in the promotion and retention models were AFQT score, sea experience, age, marital status, and rating group.

A positive relationship was found between college credits earned through VOLED as a whole and promotion to E5 in five years. Promotion estimates were based

on a single group of active duty enlisted sailors who accessed in the last two quarters of fiscal year 1992 and served in the Navy at least five years. The ordinal nature of paygrade was captured by using an ordered probit model. The extent of vacancies in the rating was also considered in the promotion model.

Regression estimates of retention were based on a single fiscal year 1992 cohort of active duty enlisted sailors with four-year contracts. A positive relationship was found between college credits earned through VOLED and reenlistments. Reenlistment bonus information was also captured in the retention model. One of the shortcomings of this analysis is that less than a year's worth of NCPACE course data was used to evaluate the effectiveness of that component and only a single cohort was evaluated for the entire VOLED program. In addition, the two-stage estimation methods in this study have limitations because the instrumental variable chosen (enrolling in distance learning courses, participating in academic counseling) and the respective outcome (successfully completing a course, promoting to E5 in five years) is likely correlated with the unobservable factor of individual motivation.

b. Buddin and Kapur (2002)

Buddin and Kapur estimated the effects of TA participation on first-term Navy and Marine Corps reenlistments. It criticized the retention model in Garcia and Joy (1998) for including sailors who separate from the Navy before the end of their term, as these sailors do not have the same chance to utilize the TA program as sailors who stay the length of their contract. They found that when members who separated early were excluded from the sample, TA users were less likely to reenlist in the Navy by 9 percentage points.

This study did not factor TA program performance, and was limited to sailors and marines who completed their first term in fiscal year (FY) 1997 and the first half of FY 1998.

c. Sticha et al. (2003)

This study evaluated the Army Continuing Education System (ACES). Similar to the Garcia and Joy study, reenlistment and promotion of first-term Active Duty Army enlisted soldiers were used as measures of effectiveness.

Sticha *et al.* estimated that TA participation resulted in a 7.6 percent increase in reenlistment rates. The reenlistment analysis looked at soldiers who began and completed a three- or four-year contract between October 1995 and September 2001 and completed enough service to become eligible for reenlistment. Soldiers stationed at installations where the Educational Management Information System (EDMIS) database was not operational were excluded. The authors acknowledged this resulted in a biased sample, as those stationed at bases in which EDMIS is operational do not make up a random sample of all first-time enlistees. Factors considered in the reenlistment model were paygrade, military specialty, reenlistment bonus information, Career Management Field (CMF), race, sex, level of education and marital status in addition to participation in TA and Functional Academic Skills Training (FAST) components of ACES. A bivariate probit model which simultaneously estimated participation in TA and reenlistment was used to control for selection bias.

Performance and promotion analysis was based on data from the NCO21 Validation Project, which collected information about ACES participation from Non-commissioned officers (NCOs). Sticha *et al.* found that participation in TA, MOSIT (Military Occupation Specialty Improvement Training) courses, and NCO Leader Skill Enhancement courses are positively associated with promotion and performance. One of the shortcomings of the database used for the performance and promotion analysis is that it had fewer than 2,000 soldiers and the course data relied on self-reported information.

d. Mehay and Pema (2008)

Mehay and Pema analyzed the impact of the Navy's TA program on the retention and promotion of first-term Navy enlisted personnel. Their approach to the selection bias problem differs from the two previously mentioned studies in that they used a sample consisting solely of TA participants, assuming that sailors who choose to

participate in TA have similar motivations and that those who withdraw were forced to do so by external circumstances such as military deployments and job duties. Their choices of control variables in their retention and promotion models were similar to those in previous studies: they used race, ethnicity, sex, education, AFQT scores, marital status, and dependents. Like the ACES study, Mehay and Pema considered multiple cohorts instead of a single one.

They noted that women used TA at twice the rate of men and had higher rates of successful course completion. They also found that minority groups were more likely to use TA than whites. Their study found that sailors who use the TA program to enroll in college classes have a significantly higher probability of reenlistment and of promotion to both E4 and E5 than those who participate but do not complete their courses. They ran models with the full sample and compared them to the models that included only TA participants and estimated the self-selection bias difference between the full sample and the TA participants. One potential problem is the assumption that sailors withdraw due to external circumstances, which may be too strong. The descriptive statistics for the restricted sample demonstrate that course completers have higher AFQT scores and also indicate that sailors who attained higher levels of education had more success in completing courses.

C. SCOPE, LIMITATIONS AND ASSUMPTIONS

This study is restricted to Navy enlisted personnel who participated in the NCPACE program between fiscal years 1995 and 2008. We excluded warrant and commissioned officers from the statistical models in order to obtain a more homogenous sample.

NCPACE courses were only available to commands with a sea duty unit identification code (UIC) of type 4, some remote locations, and to sailors supporting contingency operations (OPNAVINST 1560.9A). Sailors were also subjected to additional requirements, which evolved over time. Because data that determines a sailor's eligibility to participate in NCPACE at a given time was not available, we did not consider program participation rates.

The promotion, extension, and reenlistment models are limited in the sense that we did not obtain data which determines a sailor's eligibility to promote (such as promotion board data) or motivators for extension and reenlistment decisions (such as benefits or bonuses for these actions).

D. COURSE OF STUDY

Chapter II provides a description of the data sources and sets, some descriptive statistics and univariate analyses of course completion rate by variables of interest. Chapter III provides the variables, assumptions and results of the course completion, effects of failed courses, promotion, and reenlistment models. Chapter IV provides recommendations and conclusions. A list of references is provided at the end.

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II. DATA AND DESCRIPTIVE STATISTICS

A. DATA SOURCES AND SETS

1. Navy College Management Information System (NCMIS)

NCMIS was the source of NCPACE participation data. This data set is an accumulation of course rosters for NCPACE classes administered between fiscal years 1995 and 2009. These data provide extensive information on both students and courses. More specifically, the NCMIS data set:

- identifies course enrollments and results by individual sailor, making it possible to track individuals who have taken more than one course;
- provides demographic information about the sailor (race, ethnicity, sex), as well as characteristics about him or her (rank, rating, education level, AFQT score) at the time the request to take the course was made;
- describes course attributes, such as the title, level (lower division, upper division, graduate), credit hours and delivery method;
- gives information about the school, the command, the NCPACE office that sponsored the course, the fiscal year that the course request was made, and some information about the associated contract (contract number and costs).

The course start date was used to determine the fiscal year the course was taken. Records corresponding to courses beginning in fiscal year 2009 were removed from our sample because the set of fiscal year 2009 courses appeared to be incomplete.

2. Defense Manpower Data Center (DMDC)

DMDC provided sailor-level information on Active Duty accessions, strength, reenlistments and separations between October 1994 and December 2009.

The accession data set contained accession dates, AFQT score percentile, and a prior military service indicator at the time of accession.

The strength data set provided quarterly snapshots of the Active Duty force and included the following: branch of service, paygrade and date of rank, unit identification code, time in service, primary occupation, sex, race, ethnicity, marital status, current enlistment date, education level and enlistment contract length..

The reenlistment and separation data set contains the date of the action. The separation data contains separation codes in addition to the action date.

B. DESCRIPTIVE STATISTICS

1. Overall NCPACE Course Enrollments

NCMIS reported 262,479 NCPACE course records between fiscal year 1995 and fiscal year 2009. This section considers 260,803 records, which corresponded to courses with valid course start dates between fiscal year 1995 and fiscal year 2008.

The number of overall NCPACE courses taken varied by fiscal year, with an increase between 1995 and 2001, a decrease between 2001 and 2005, and an increase between 2005 and 2006 (Figure 1). The proportion of Technology courses taken varied between 32.8 percent (fiscal year 2004) and 51.8 percent (fiscal year 2007). The decrease in overall participation between 2001 and 2005 may be explained by increases in sailor duties as a result of the events that occurred on September 2001. It is likely not explained by changes in the number of eligible participants, as the changes in the number of courses taken did not correspond to changes in Navy enlisted end strength figures during this time period (Figure 2).

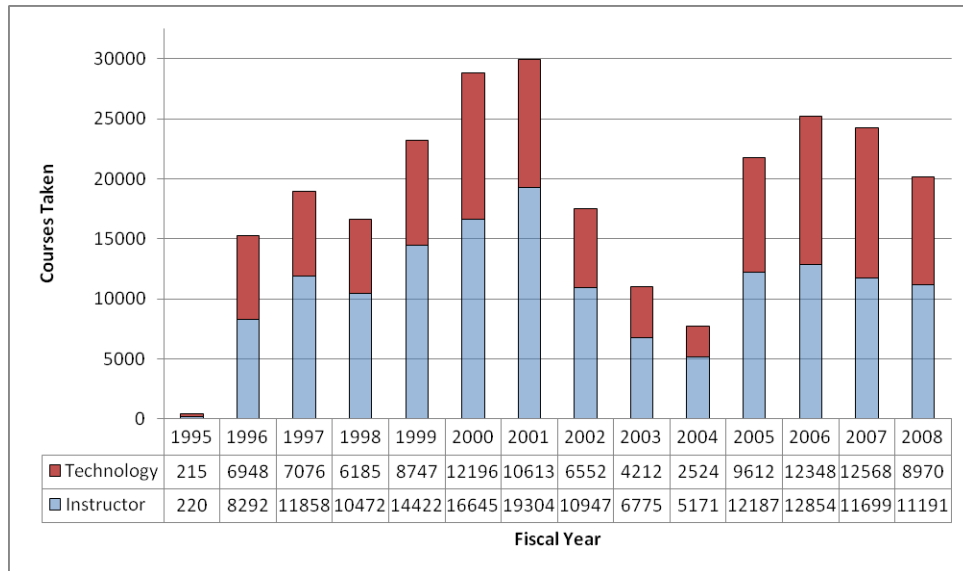


Figure 1. NCPACE Courses Taken by Fiscal Year (FY1995–FY2008).
Source: NCMIS.

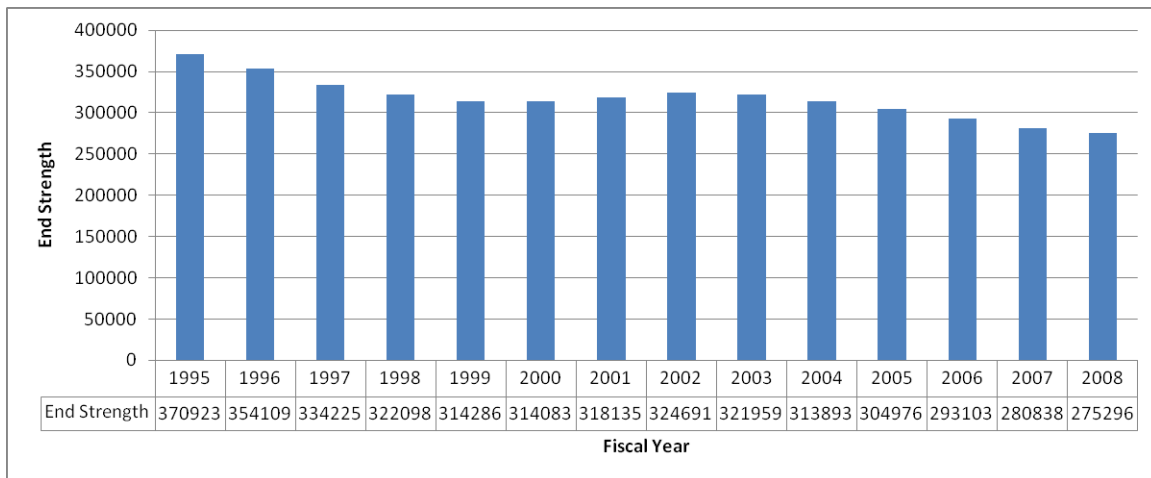


Figure 2. Navy Enlisted End Strength by Fiscal Year (FY1995–FY2008).
Source: DMDC.

The proportion of successful course completions generally hovered around 70 percent, with a decrease in completion rates that began in 1999 that lasted through 2003 (Figure 3; note that the vertical scale starts at 50 percent).¹ Excluding Invalid/Unknown

¹ *Succeeded* was defined as attaining a course grade of A, B, B+, C, or S. *Did Not Succeed* was defined as attaining a course grade of D, DP, F, FN, I, N, NC, NF, NS, W, WA, WD, WF, WP or WX. *Invalid/Unknown* course grades were not factored into the denominator of the percentages but are shown in the graph.

observations, the highest course completion rate was experienced in 2008; however, this year also experienced the highest number of invalid and unknown course grades. Changes in course completion rates could be the result of NAVADMIN 109/04, NAVADMIN 161/07 and NAVADMIN 042/08.

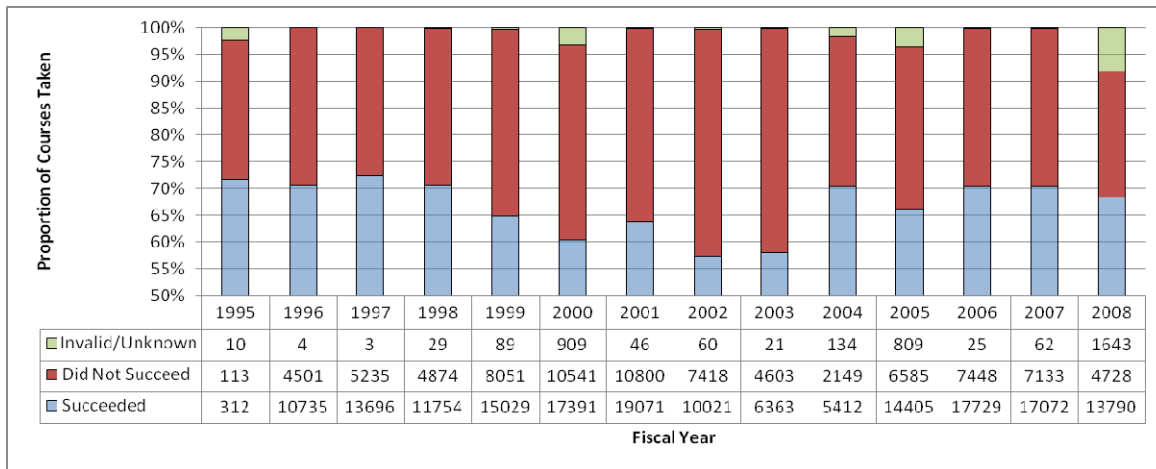


Figure 3. NCPACE Success Rate by Fiscal Year (FY1995–FY2008).
Source: NCMIS.

An overwhelming majority of NCPACE courses were taken by enlisted personnel. Between fiscal years 1995 and 2008, 97 percent of course attempts were made by enlisted personnel, with 82.5 percent of attempts made by sailors with paygrades of E3 through E6 (Figure 4). The remainder of this thesis is restricted to Navy enlisted personnel, with the assumption that this population is homogenous in motivation.

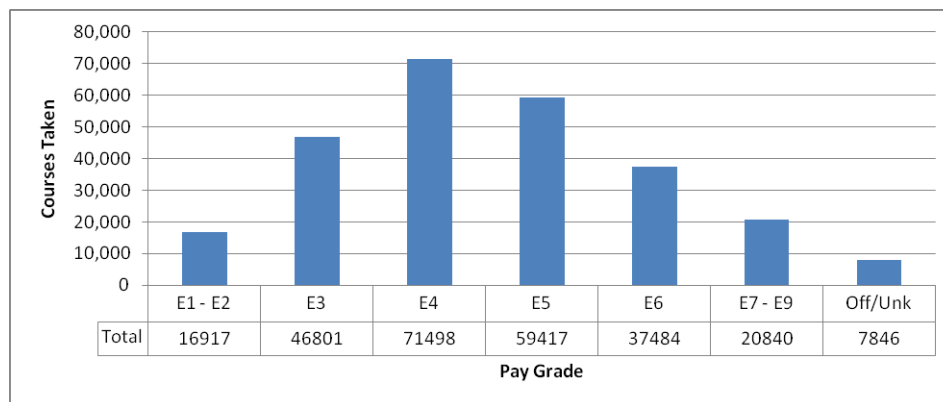


Figure 4. Courses taken by Pay Grade at the Time of the Course (FY1995–FY2008). Source: NCMIS.

2. First-time NCPACE Enrollments

A considerable number of participants have taken more than one course. Figure 5 shows the number of courses taken versus the number of participants by fiscal year. As a key objective of this thesis is to serve as a tool for screening participants, we have chosen to evaluate the first course taken for each participant. We assume that participants who make second attempts and beyond can be screened based on previous performance.

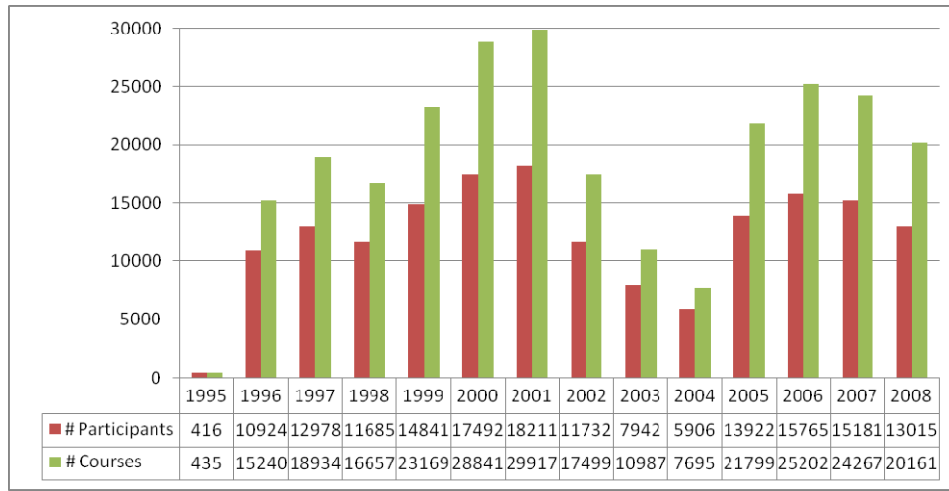


Figure 5. NCPACE Courses versus Students by Fiscal Year (FY1995–FY2008).
Source: NCMIS.

A data set containing first-time NCPACE enrollees with valid enlisted paygrades was extracted from the NCMIS course roster. We chose the record with the earliest start date for each individual enrollee and validated that enrollment record against the corresponding DMDC quarterly strength file. From this data set, only records with valid course grades were retained. The resulting data set contains 112,914 observations. First course attempts and success rates experience trends similar to those of overall NCPACE course enrollment levels and success rates. The remainder of this section examines how first course success rates vary by course and sailor factors considered individually.

The rate of successful first course completions varied by course attributes. Three-fourths (75.9 percent) of Instructor-based course participants succeeded, whereas only about half (48.1 percent) of Technology-based course participants succeeded (Figure 6). Different success rates were also observed across course subjects (Figure 7). Those who

took mathematics (58.3 percent) and physical and other science (50.3 percent) courses did not succeed at rates comparable to those who took humanities, social science and business courses (67.1 percent). In addition, the success rate varied across the schools that administered the course (Figure 8). 75.4 percent of first time participants who took courses through Central Texas College succeeded, while only 37.6 percent of participants who took courses through Richland College succeeded.

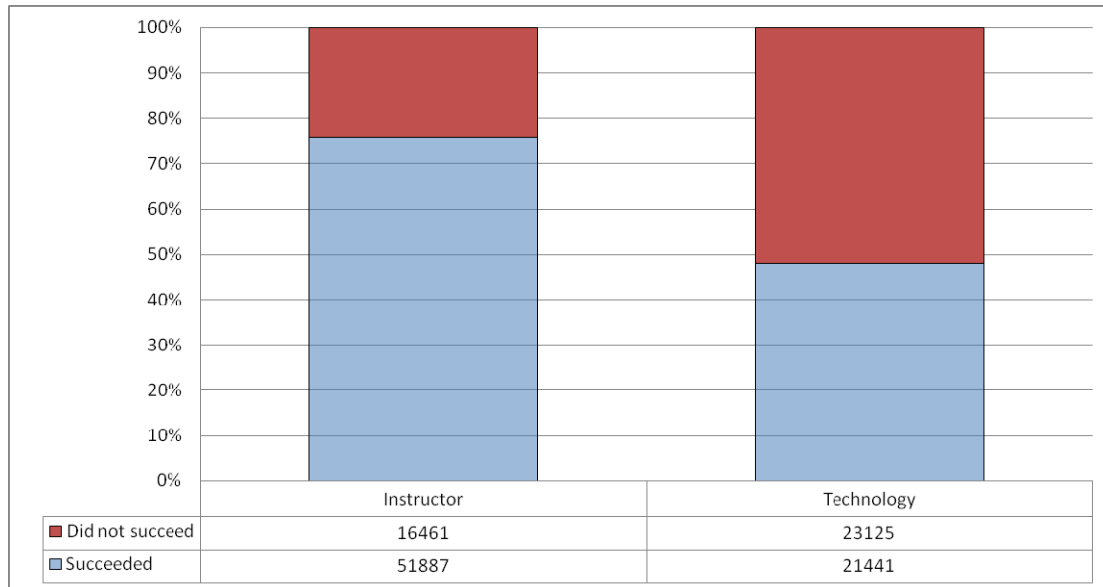


Figure 6. NCPACE First Course Success Rate by Course Delivery Method (FY1995–FY2008). Source: NCMIS.

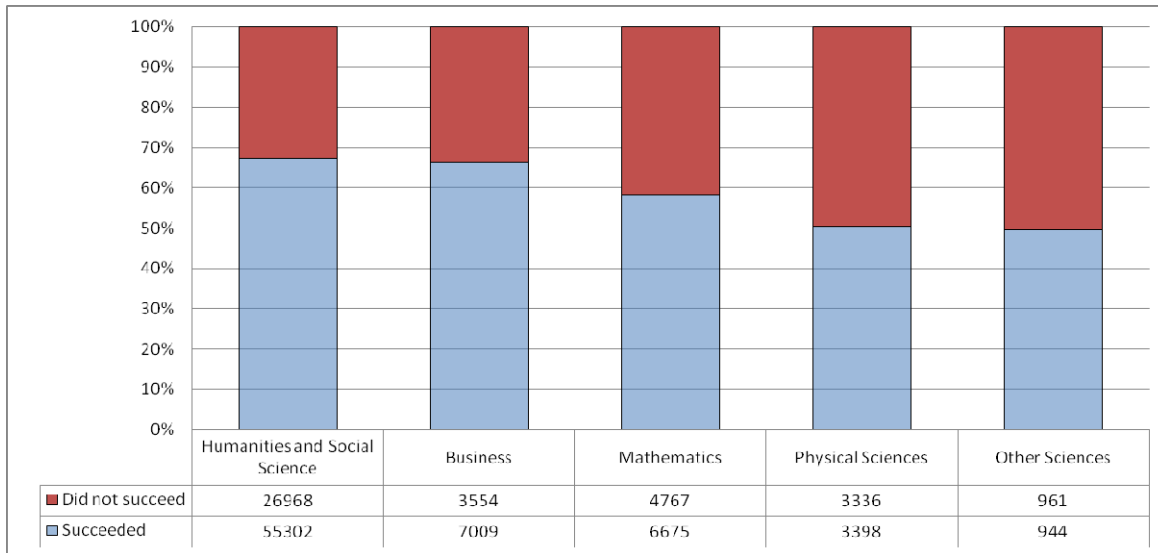


Figure 7. NCPACE First Course Success Rate by Course Subject (FY1995–FY2008).
Source: NCMIS.²

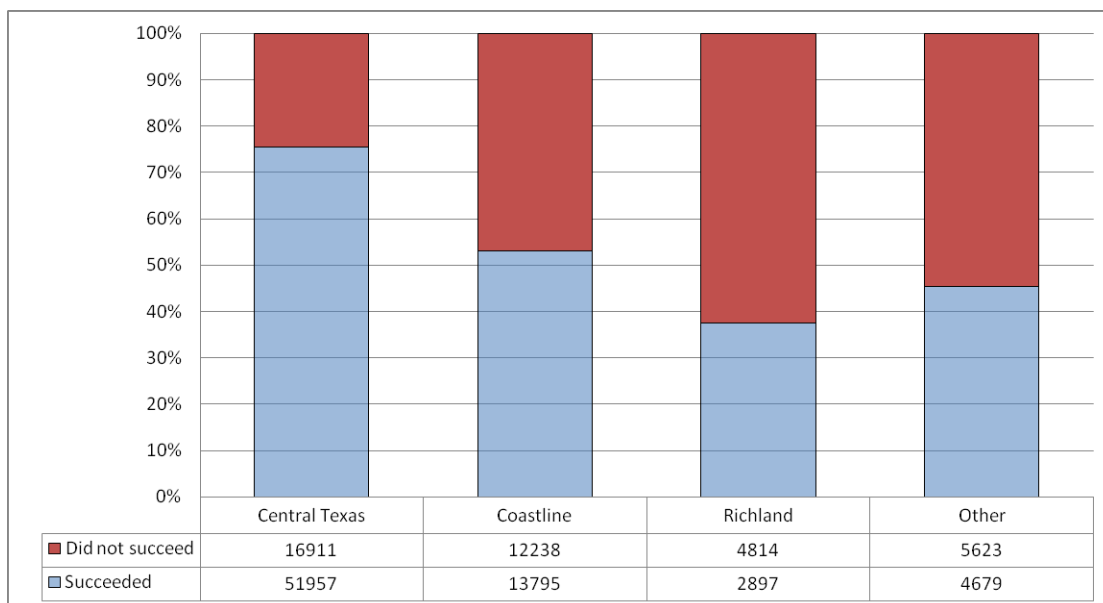


Figure 8. NCPACE First Course Success Rate by School (FY1995–FY2008).
Source: NCMIS.

The rate of successful first course completions also varied by attributes of the sailor taking the course. Sailors who completed at least some college were most successful, whereas those who held an alternative high school credential were least

² Course categories were determined by a combination of course subject and title reported by NCMIS.

successful (Figure 9). Higher ranked sailors succeeded at higher rates than lower ranked sailors (Figure 10). Also, there is some variance in success by rating (Figure 11) and unit type (Figure 12).

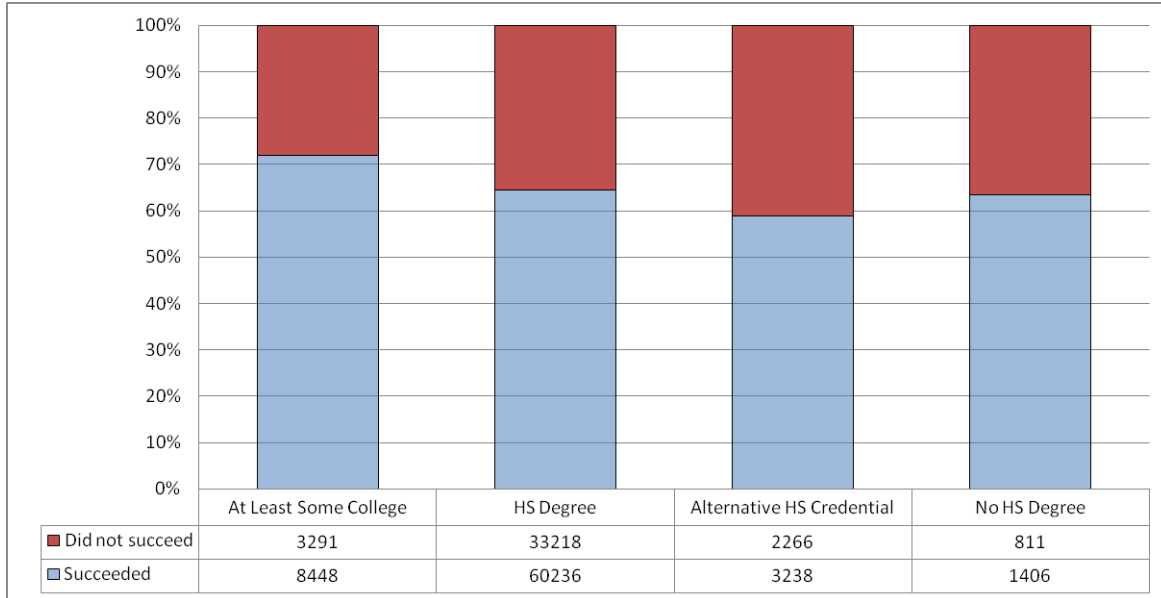


Figure 9. NCPACE First Course Success Rate by Education Level (FY1995–FY2008).
Source: NCMIS.

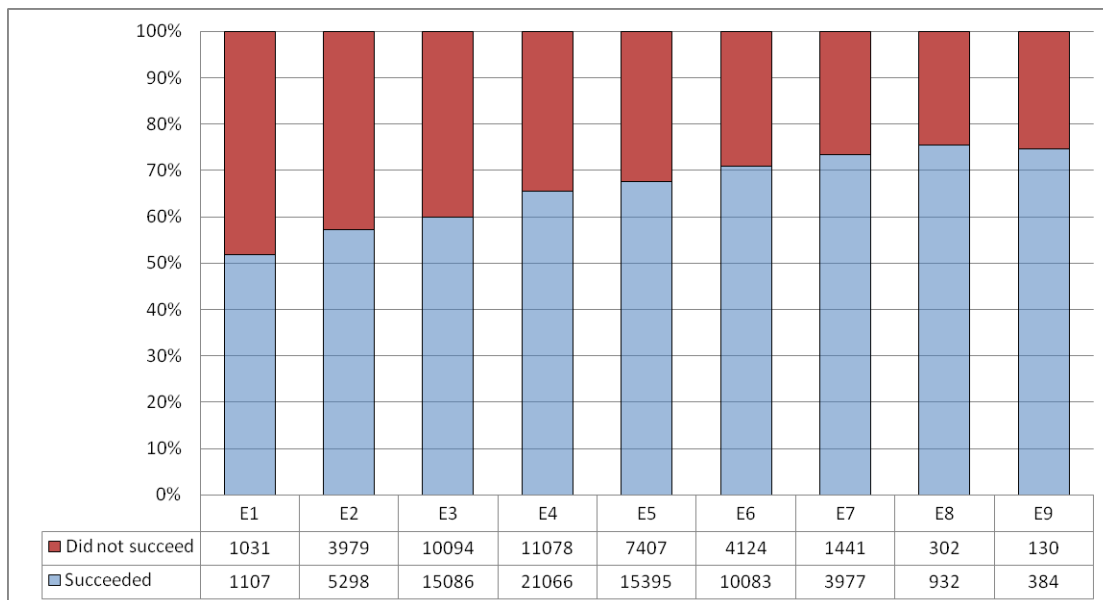


Figure 10. NCPACE First Course Success Rate by Rank (FY1995–FY2008).
Source: NCMIS.

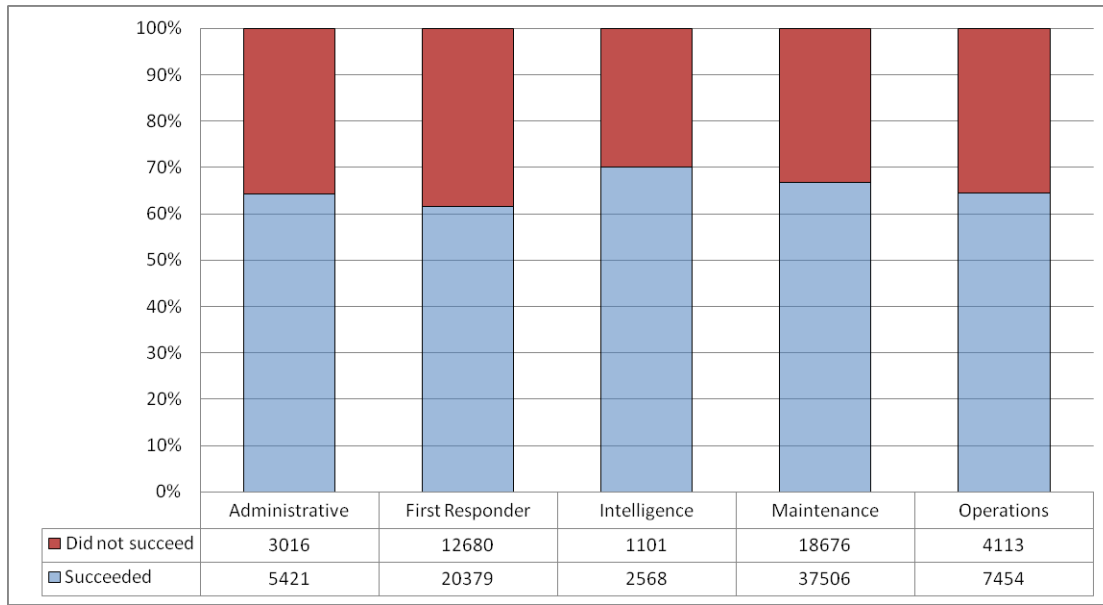


Figure 11. NCPACE First Course Success Rate by Rating Group (FY1995–FY2008).
Source: NCMIS and Navy Enlisted Manpower and Personnel Classifications and Occupational Standards (*Navy Enlisted Manpower and Personnel Classifications and Occupational Standards*, 2010).³

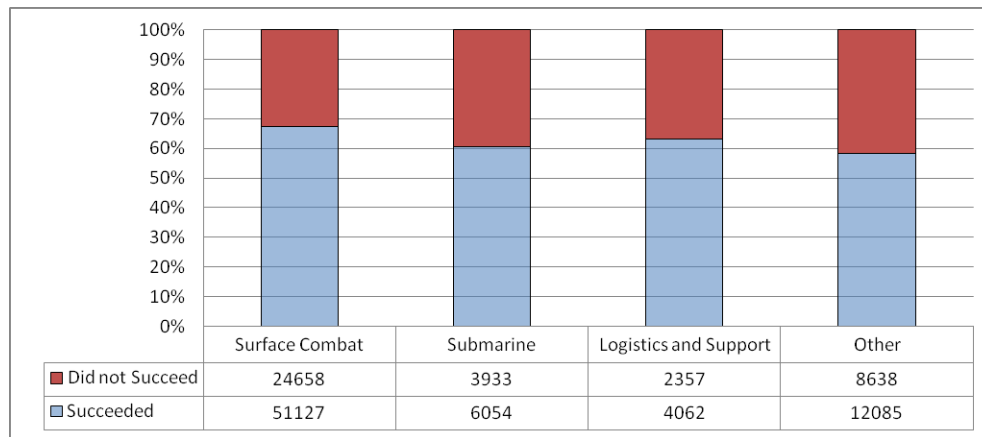


Figure 12. NCPACE First Course Success Rate by Unit Type (FY1995–FY2008).
Source: NCMIS and Naval Vessel Register (NVR).⁴

³ Chapter III.A.2 describes the categorization of ratings in detail.

⁴ Chapter III.A.2 describes the categorization of unit types in detail.

Some variation in success rates were observed between the following groups:

- AFQT Category I-III A (66.3 percent) and AFQT Category IIIB-V (61.3 percent success rate).
- Married (68.7 percent) and unmarried (62.5 percent) sailors.

Little variation in success rates were observed in the following sailor characteristics:

- Sex: Females (65.3 percent) and males (64.9 percent).
- Race: American Indian/Alaskan Natives (64.1 percent), Asians (66.8 percent), Blacks (64 percent), Pacific Islanders (66.9 percent), Whites (65.9 percent) and Other (63.3 percent).
- Ethnicity: Hispanics (65 percent) and non-Hispanics (64.3 percent).

3. Impact of Failing the First Course

This study also aims to quantify the impact of failing the first course. We merged information about subsequent NCPACE course attempts to the data set of first-time enrollments described in the previous section in order to:

- determine if sailors who did not succeed at their first attempt make subsequent attempts.
- evaluate the performance of sailors who did not succeed at their first attempt who make subsequent attempts.

For each participant, we defined the subsequent attempt as the course with the earliest reported start date occurring after the first course's reported completion date. Records with second courses that did not have valid enlisted paygrades or course grades were not considered. This resulting data set contained 112,444 observations, with 50,474 instances of subsequent course attempts.

Successful completions of first courses seem to be positively associated with enrollments in subsequent courses. Overall, 44.9 percent of NCPACE participants made a subsequent attempt after the completion of their first course. Less than one-third (32.1 percent) of the participants who did not successfully complete their first course made a subsequent attempt, whereas about half (51.8 percent) of those who succeeded made a subsequent attempt (Figure 13).

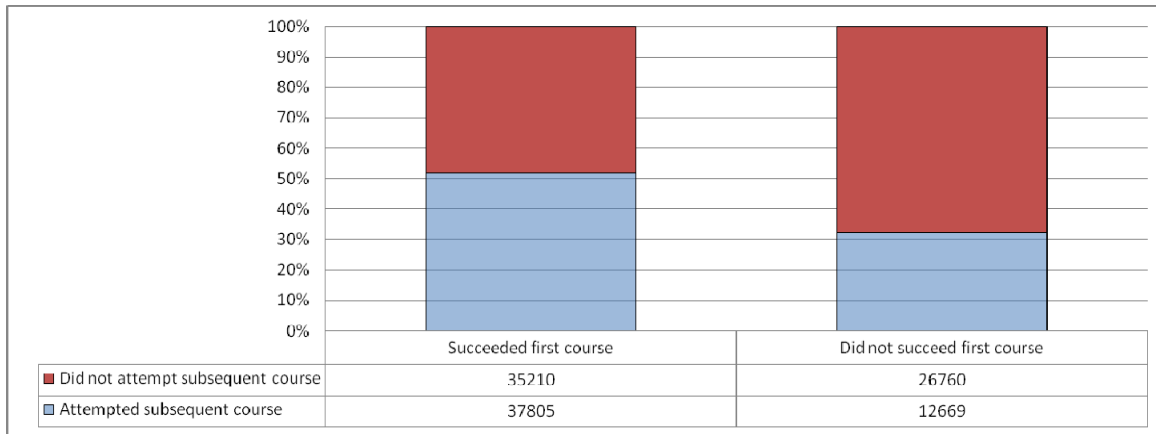


Figure 13. Rate of Subsequent NCPACE Course Attempts by Result of First Course (FY1995–FY2008). Source: NCMIS.

There is also some indication that successfully completing a first course is associated with successfully completing subsequent ones. While the overall subsequent course completion rate of 66.9 percent is comparable to the first course completion rate of 65 percent, there is a noticeable difference by first course results. Seventy-five percent of participants who successfully completed their first course and taken a subsequent course passed the subsequent course, whereas only 42 percent of participants who did not successfully complete their first course and taken a subsequent course passed the subsequent course (Figure 14).

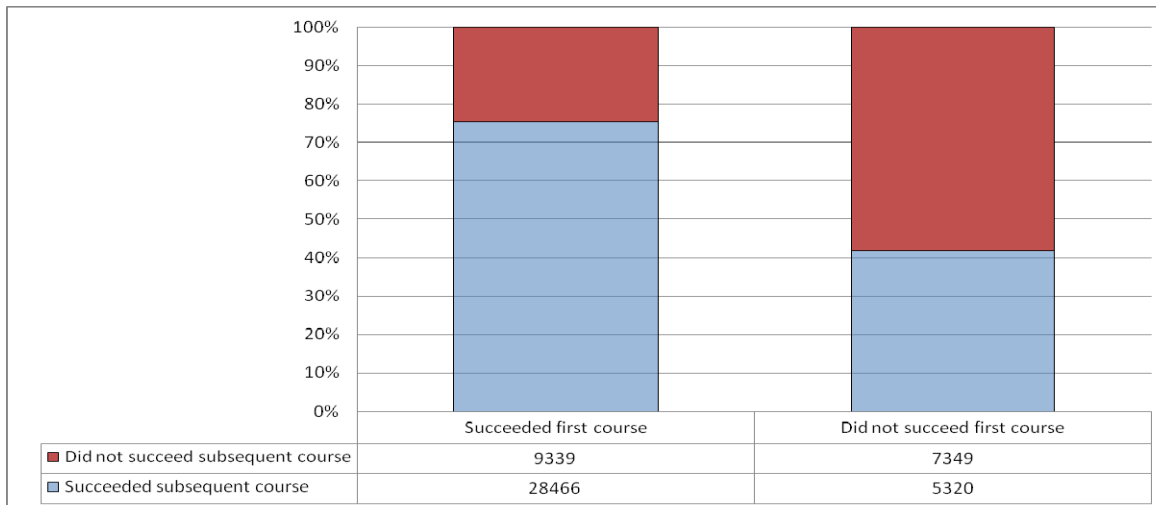


Figure 14. Success Rate of Subsequent NCPACE Courses by Result of First Course (FY1995–FY2008). Source: NCMIS.

4. Impact on Promotion and Retention

Lastly, this study examines if NCPACE course outcomes have promotion and retention effects on first-term sailors with four-year contracts and non-prior service accessions occurring between fiscal years 1995 and 2004. We created the following data sets using the source data:

- Using the NCMIS course roster, we consolidated each participant's course history into a single record, which reported the course start dates associated with the first successful and unsuccessful attempts. We also captured NCPACE participant demographics at the time of the first course to include the fiscal year of the first course attempt.
- Using the DMDC accession data, we identified non-prior service Navy accessions, capturing the date of accession.
- Using the DMDC strength data, we captured additional NCPACE participant demographic information at the time of the first course and identified participants:
 - with 48-month contracts.
 - who continued to serve beyond their 48-month contract.
 - who promoted to E5 before the end of their 48-month contract.We chose to evaluate promotions to E5 due to the competitive nature of receiving this promotion within the first four years of service.
- Using the DMDC reenlistment and separation data, we captured the first reenlistment or separation decision.

These datasets were merged. In a manner analogous to that in the study of Mehay and Pema (2008), we restricted our sample to NCPACE participants who took at least one course during their first term, with a successful participant defined as a sailor who

successfully completed at least one course in their first term. We defined the first term as the period between accession and 48 months thereafter.⁵ The resulting data set contains 47,406 observations.⁶

We found that those who succeeded in at least one NCPACE course promoted to E5 within 48 months of service at higher rates than those who did not (54.2 versus 49.1 percent; Figure 15). However, it is worth noting that other things such as rating vacancies are a major factor of a participant’s promotion potential. We found that extension and reenlistment rates do not vary much with respect to NCPACE success (Figures 16 and 17).

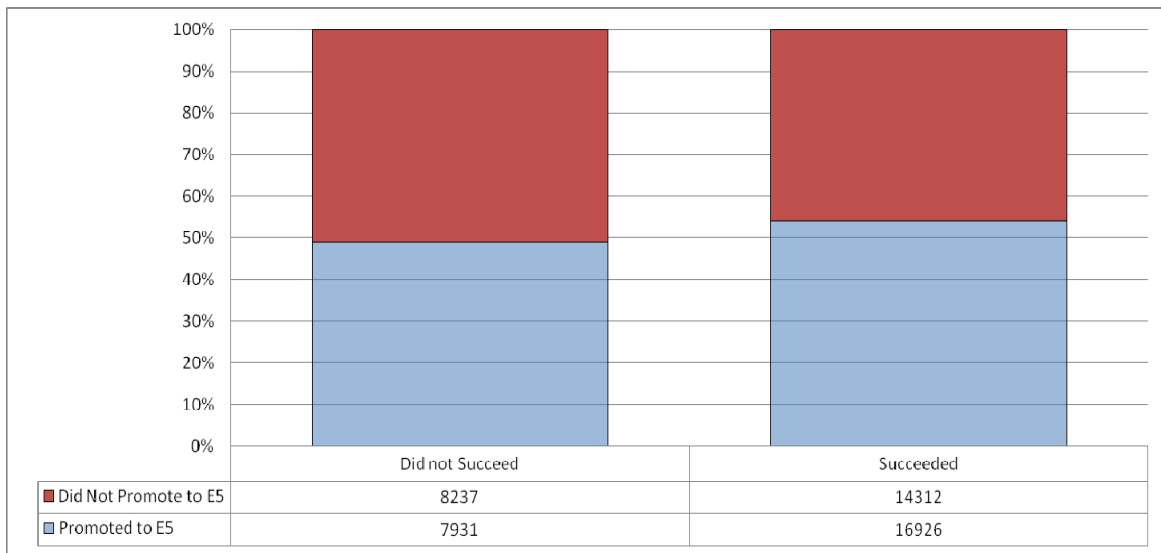


Figure 15. Rate of Promotion to E5 by NCPACE Success (FY1995–FY2003 Accessions).
Source: NCMIS and DMDC.

⁵ We defined the first term in this manner versus using the reported reenlistment and separation action dates because over a quarter of the sample had action dates that occurred more than one year after the end of their contract obligation.

⁶ We included 16,686 sailors who left before serving 36 months of their 48-month contract. It is worth noting that this dataset contains 124 observations which report the sailor’s paygrade as E6 or above at the time of his or her first course.

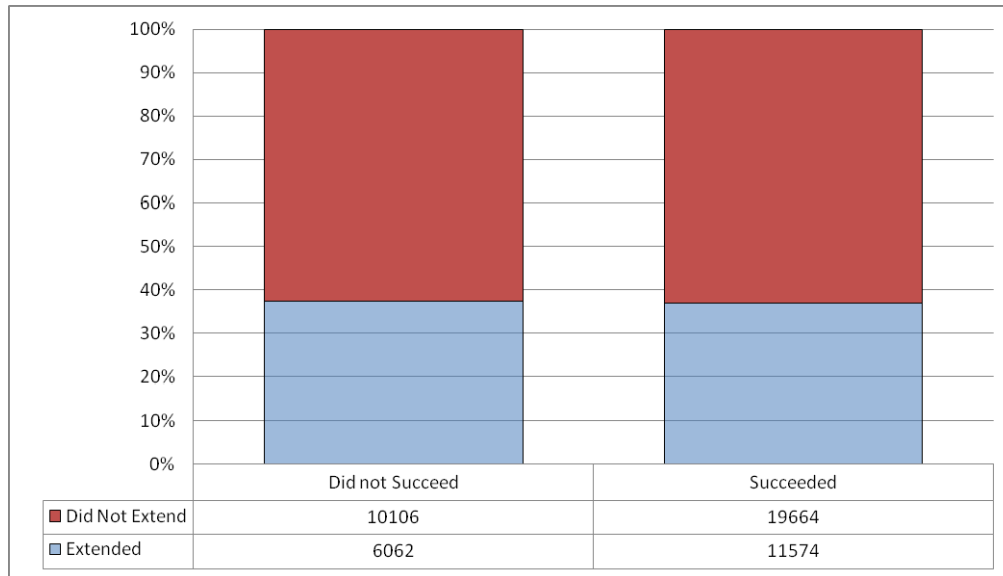


Figure 16. Rate of Extension by NCPACE Success (FY1995–FY2003 Accessions).
Source: NCMIS and DMDC.

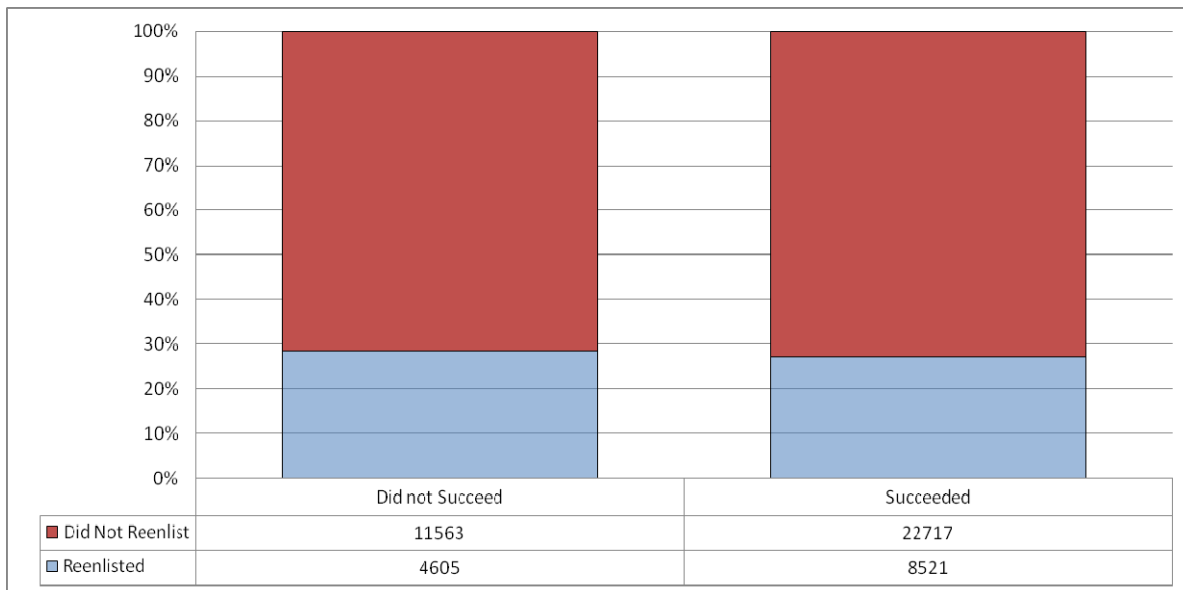


Figure 17. Rate of Reenlistment by NCPACE Success (FY1995–FY2003 Accessions).
Source: NCMIS and DMDC.

III. REGRESSION ANALYSIS

A. COURSE COMPLETION MODEL

The course completion model seeks to identify sailor and course factors associated with successful first attempts. We used the data set of first-time NCPACE enrollments described in the previous chapter for the course completion model.

1. Dependent Variable

The dependent variable for this model is an indicator variable that equals 1 if the course was completed successfully and 0 if the course was not completed successfully. Letter grades below “C minus,” non-passing marks in non-letter graded courses, incompletes, and withdrawals were defined as unsuccessful attempts. A successful course completion is defined as receiving a “C minus” or above in letter graded courses or a passing mark in non-letter graded courses. Course records with invalid grades were dropped from the data set.

2. Independent Variables

The independent variables we chose are heavily based on previous voluntary education studies. We considered the following course characteristics:

- Course delivery method. Garcia and Joy (1998) and Woosely (2009) reported differences between traditional classroom (Instructor) and distance learning (Technology) methods. Course delivery methods are categorized as Instructor or Technology.
- Course subject. Garcia and Joy (1998) and Woosely (2009) indicate that completion rates for mathematics and physical sciences were lower than other courses. We used course subjects and titles to categorize courses into the following academic disciplines: Humanities and Social Science, Business, Mathematics, Physical Sciences, and Other Sciences.

- Unit vessel type. The study of Garcia and Joy (1998) indicated that submariners experienced higher completion rates. We mapped hull numbers found in Unit Identification Code titles provided by NCMIS to vessel classification information from the Naval Vessel Register and created the following unit types:
 - Surface Combat
 - Aircraft Carrier
 - Amphibious Warfare
 - Coastal Defense
 - Mine Warfare
 - Surface Combatant
 - Submarine
 - Logistics and Support
 - Combat Logistics
 - Mobile Logistics
 - Support
 - Other Unit Type
- Fiscal year of course start date. This was included in order to control for changes in NCPACE and Navy policies over time.
- School. Unlike Tuition Assistance, which can be applied towards the educational institution of the sailor's choice, NCPACE courses are offered by a more or less fixed set of schools. Of the 19 schools that administered NCPACE courses, three schools administered over 90 percent of the courses associated with first attempts. We have categorized schools as

follows to control for the variation that may occur among them: Central Texas College, Coastline Community College, Richland College, and Other School.

We considered the following sailor characteristics in the course completion model. Factors that may vary over time were captured around the start of the course:

- AFQT percentile score. AFQT percentile score is a continuous variable ranging from 0 to 99 which captures the sailor's performance on the Armed Forces Qualification Test.
- Education. Education reports the level of education attained by the sailor and has been used in past studies to capture an individual's motivation. We have chosen the following categories: Did Not Complete High School, received an Alternative High School Credential, received a High School Diploma, and Completed at Least Some College.
- Rank. Enlisted ranks are treated as categorical variables.
- Rating. Navy enlisted ratings are classified into 23 occupational fields as defined by *Navy Enlisted Manpower and Personnel Classifications and Occupational Standards*. We grouped the occupational fields into five areas based on functional area:
 - Administrative
 - Administration (LN, NC, PS, RP, YN)
 - Communications (IT)
 - Logistics (LS, SH)
 - Media (MC)
 - Music (MU)
 - First Responder
 - Health Care (HM)

- Law Enforcement/Security (MA)
- Intelligence and Special Warfare
 - Cryptology (CTI, CTM, CTN, CTR, CTT)
 - Intelligence (IS)
 - Special Warfare/Diving (EOD, ND, SB, SO)
- Maintenance
 - Aviation Ground Support (ABE, ABF, ABH, AS)
 - Aviation Maintenance/Weapons (AD, AE, AM, AME, AO, AT, AZ, PR)
 - Construction (BU, CE, CM, EA, EO, SW, UT)
 - General Seamanship (BM)
 - Marine Engineering (EM, EN, GSE, GSM, IC, MM)
 - Ordnance Systems (GM, MN, MT)
 - Ship Maintenance (DC, HT, MR)
 - Weapons Control (ET, FC, FT)
- Operations
 - Air Traffic Control (AC)
 - Aviation Sensor Operations (AW)
 - Meteorology and Oceanography (AG)
 - Sensor Operations (STG, STS)
 - Ship Operations (OS, QM)
- Race. We grouped the races into the following categories: White, American Indian/Alaska Native, Asian, Black or African American, Native Hawaiian or other Pacific Islander, and Other Race.

- Ethnicity. We divided this group into Hispanic and non-Hispanic. Sailors with an ethnicity of Cuban, Mexican, Puerto Rican, Latin American of Hispanic Descent, and Other Hispanic Descent were defined as Hispanic.
- Sex. We divided this group into Male and Female.
- Marital status. We divided this group into Married and Not Married.

3. Model Assumptions, Model, and Model Diagnostics

Logistic regression models were used to predict outcomes throughout this chapter. To predict the successful completion of the first course for participant i , we assume $Course\ completion_i$ is a Bernoulli random variable with probability distribution as follows:

$Course\ completion_i$	Probability
1	$P(Course\ completion_i = 1) = \pi_i$
0	$P(Course\ completion_i = 0) = 1 - \pi_i$

Table 1. Probability Distribution of $Course\ completion_i$

We chose the following logistic response function:

$$E(\pi_i) = \frac{\exp(\mathbf{x}_i' \boldsymbol{\beta})}{1 + \exp(\mathbf{x}_i' \boldsymbol{\beta})}$$

where $\mathbf{x}'_i = [1, Course\ delivery\ method_i, \dots, Marital\ status_i]$ and $\boldsymbol{\beta}' = [\beta_0, \beta_1, \dots, \beta_{13}]$.

The equivalent logit transformation is $\ln \frac{\pi_i}{1 - \pi_i} = \beta_0 + \beta_1 Course\ delivery\ method + \beta_{2i} Course\ subject_i + \beta_{3i} Unit\ type_i + \beta_{4i} Fiscal\ year_i + \beta_{5i} School_i + \beta_6 AFQT + \beta_{7i} Education_i + \beta_{8i} Rank_i + \beta_{9i} Rating_i + \beta_{10i} Race_i + \beta_{11} Ethnicity + \beta_{12} Sex + \beta_{13} Marital\ status$ (Montgomery, 2001). The analysis of deviance table corresponding to the course completion model demonstrates that each of the selected factors is statistically significant at the .05 level (Table 2).

	Df	Deviance	Resid. Df	Resid. Dev	Pr(Chi)
NULL			101000	132000	
Technology	1	8330	101000	123000	0
CourseType	4	585	101000	123000	0
UnitType	3	875	101000	122000	0
FY	13	1400	101000	120000	0
School	3	654	101000	120000	0
Afqt	1	1360	101000	118000	0
Education	3	706	101000	118000	0
Rank	8	2570	101000	115000	0
Rating	4	41.9	101000	115000	1.76E-08
Race	5	37.3	101000	115000	5.22E-07
Hispanic	1	11.9	101000	115000	0.000567
Female	1	65	101000	115000	7.77E-16
Married	1	19.1	101000	115000	1.22E-05

Table 2. Course Completion Model Analysis of Deviance Table

We used the Hosmer-Lemeshow test to assess the goodness-of-fit of the logistic regression models in this thesis. This test evaluates subgroups of subjects based on the percentile of the estimated probabilities from the model and measures the difference between the observed number of occurrences (from the data set) and the expected number of occurrences (based on the model) for each subgroup. The test statistic is defined as:

$$\tilde{C} = \sum_{k=1}^g \frac{(o_k - n_k \bar{\pi}_k)^2}{n_k \bar{\pi}_k (1 - \bar{\pi}_k)}$$

where n subjects are divided into g subgroups each of approximate size $n_k' = n/g$. If $g =$

100, the k th group contains subjects in the k th percentile. Then we define o_k as $\sum_{j=1}^{n_k'} y_j$,

the observed number of completions in the k th group, and $\bar{\pi}_k$ as $\sum_{j=1}^{n_k'} \frac{m_j \hat{\pi}_j}{n_k'}$, the expected number of completions in that group under the model. The distribution of \tilde{C} is approximated by the chi-square distribution with $g - 2$ degrees of freedom (Hosmer and Lemeshow, 1989).

Because of the size of our data sets, we chose 100 as the value of g . The resulting Hosmer-Lemeshow test statistic for the course completion model has a p-value of 0.0098 (Chi-squared = 133.608, df = 98), and Figure 18 is a plot of the observed versus expected

values for the course completion model. Although the p-value of the test statistic is slightly smaller than .01, the plot indicates that the model fits the data “reasonably” well.

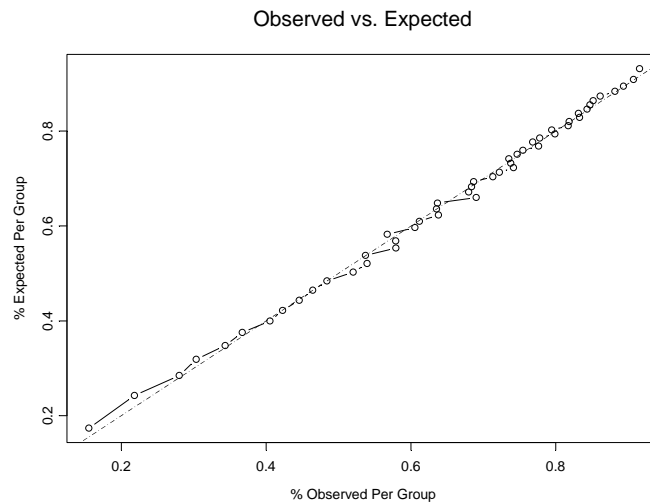


Figure 18. Hosmer-Lemeshow Plot of Course Completion Model

The Receiver Operating Characteristic (ROC) is a function that relates the hit rate (sensitivity) to the false-alarm rate (false positive rate). The diagonal line where sensitivity = false positive rate represents the chance line, that is, the ROC for a classification which predicts completion purely at random (Egan, 1975). The area under a model’s ROC curve (AUC) suggests that model’s ability to accurately predict the value of an observation’s response. Hosmer and Lemeshow’s guidelines for interpreting AUC values are in Table 3 (Minitab Technical Support Document).

AUC = 0.5	No discrimination
$0.7 \leq \text{AUC} < 0.8$	Acceptable discrimination
$0.8 \leq \text{AUC} < 0.9$	Excellent discrimination
$\text{AUC} \geq 0.9$	Outstanding discrimination

Table 3. Guidelines for Interpreting Area Under the ROC Curve. Source: Minitab Technical Support Document.

Figure 19 shows the ROC curve for the course completion model. We have “acceptable” classification results, as all points of the ROC are above the chance line and the area under the curve (AUC) is 0.732.

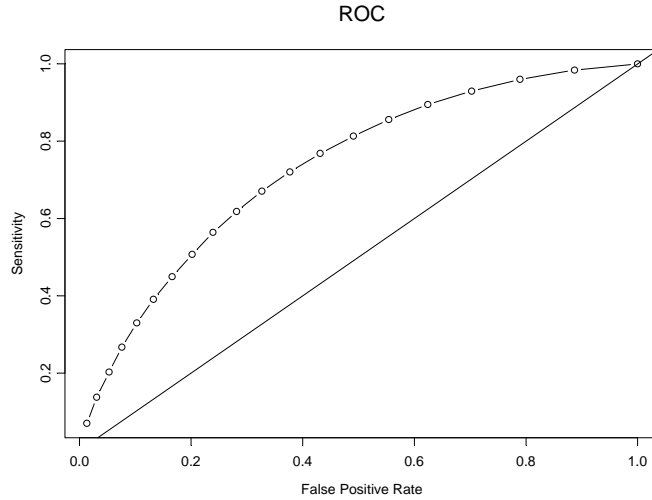


Figure 19. ROC Curve of Course Completion Model

4. Analysis

The results of the course completion model are presented in Table 4. We reject the null model in favor of this model, as our difference-in-deviance test statistic 16646.2 is greater than $\chi^2_{\alpha,48}$ for any reasonable choice for α . The results of this fixed-effects model corroborated the following findings in the study of Garcia and Joy (1998):

- The predicted success rate increases with rank. E4s were twice as likely to successfully complete their first course than E1s. E6s were about three times more likely to complete than E1s.
- Instructor-based courses have higher predicted success rates. Participants who take Instructor PACE courses were about ten times more likely to succeed than those taking Technology PACE courses.
- Mathematics courses have lower predicted success rates. We found that Science courses also have lower predicted success rates.
- Submarine units have higher predicted success rates.

We also observed the following:

- Higher AFQT scores and levels of education were associated with higher predicted success rates. Participants who have taken some college courses were twice as likely to succeed compared to those who did not finish high school.
- Courses sponsored by Coastline Community College have higher predicted success rates.

	Value	Deviance	Resid. Df	Resid. Dev	Pr(Chi)	Odds Ratio
(Intercept)	-0.144	0.163	-0.885	0.782	0.377	0.866
Technology	-2.3	0.0689	-33.5	1120	0	0.0998
CourseTypeBus	0.0561	0.0258	2.18	4.75	0.0293	1.06
CourseTypeMath	-0.514	0.0236	-21.8	474	0	0.598
CourseTypePSci	-0.0758	0.0307	-2.47	6.09	0.0136	0.927
CourseTypeOSci	-0.239	0.0514	-4.66	21.7	0	0.787
UnitTypeOther	0.294	0.036	8.16	66.6	0	1.34
UnitTypeSubmarine	0.642	0.0409	15.7	246	0	1.9
UnitTypeSurfaceCombat	0.159	0.032	4.96	24.6	0	1.17
FY1996	-0.218	0.14	-1.55	2.41	0.121	0.804
FY1997	-0.335	0.14	-2.38	5.68	0.0172	0.716
FY1998	-0.435	0.141	-3.09	9.52	0.002	0.647
FY1999	-0.75	0.14	-5.36	28.7	0	0.472
FY2000	-0.832	0.14	-5.95	35.4	0	0.435
FY2001	-0.815	0.14	-5.82	33.9	0	0.443
FY2002	-0.913	0.141	-6.48	42	0	0.401
FY2003	-0.792	0.143	-5.54	30.6	0	0.453
FY2004	-0.376	0.143	-2.63	6.89	0.0087	0.687
FY2005	-0.453	0.141	-3.22	10.4	0.0013	0.636
FY2006	-0.293	0.14	-2.09	4.36	0.0368	0.746
FY2007	-0.246	0.141	-1.75	3.06	0.0804	0.782
FY2008	-0.219	0.141	-1.55	2.4	0.121	0.803
SchoolCoastline	0.695	0.0693	10	101	0	2
SchoolRichland	-0.0417	0.072	-0.579	0.335	0.563	0.959
SchoolOtherSchool	0.226	0.0706	3.2	10.2	0.0014	1.25
Afqt	0.0123	0.0004	29.4	862	0	1.01
EducationalthHS	0.0555	0.0644	0.862	0.742	0.389	1.06
EducationHS	0.301	0.0567	5.31	28.2	0	1.35
EducationsomeColl	0.675	0.0611	11	122	0	1.96
RankE2	0.207	0.0545	3.8	14.4	0.0002	1.23
RankE3	0.354	0.0513	6.9	47.6	0	1.43
RankE4	0.687	0.0519	13.2	175	0	1.99
RankE5	0.931	0.0535	17.4	303	0	2.54
RankE6	1.22	0.0559	21.8	474	0	3.37
RankE7	1.41	0.0626	22.5	505	0	4.09
RankE8	1.64	0.0903	18.1	329	0	5.14
RankE9	1.59	0.124	12.8	163	0	4.89
RatingFR	0.0604	0.0496	1.22	1.48	0.223	1.06
RatingIn	0.247	0.0443	5.58	31.1	0	1.28
RatingMa	0.0986	0.0179	5.51	30.4	0	1.1
RatingOp	0.109	0.0266	4.09	16.8	0	1.12
RaceAIAN	-0.0661	0.0465	-1.42	2.02	0.155	0.936
RaceAsian	0.157	0.0384	4.08	16.6	0	1.17
RaceBlack	-0.0664	0.0178	-3.73	13.9	0.0002	0.936
RacePI	0.115	0.119	0.968	0.937	0.333	1.12
RaceOtherRace	-0.0141	0.0232	-0.607	0.369	0.544	0.986
Hispanic	0.0706	0.0216	3.26	10.7	0.0011	1.07
Female	0.168	0.0203	8.25	68.1	0	1.18
Married	0.0749	0.0171	4.37	19.1	0	1.08
Null Deviance: 131532.1 on 101481 degrees of freedom Residual Deviance: 114885.9 on 101433 degrees of freedom 11432 observations deleted due to missing values						

Table 4. Course Completion Model Results

B. FIRST COURSE EFFECTS MODELS

In addition to identifying factors affecting course completions, we attempted to estimate the effects of first course results on subsequent attempts. This was done to evaluate a failed first course's potential as a learning experience for the sailor and a screening tool for NCPACE. Though passing the first course and passing a subsequent course are both correlated with a sailor's innate ability and motivation to succeed academically, passing a subsequent course may also be a function of skills acquired from the first course such as effective study habits and time management. Since NCPACE participants are working full time aboard ships, sometimes on non-traditional work schedules, these skills are especially of valid concern. The outcome of the first course can be a valuable tool for both sailors and NCPACE administrators to evaluate whether sailors have learned the necessary skills in addition to having the ability and motivation to succeed.

We used the data set of first and second NCPACE course attempts described in the previous chapter to evaluate how a first course affects a sailor's decision to attempt a subsequent course and how a first course result affects a sailor's performance in a subsequent course given that the sailor decides to attempt a subsequent course. Approximately 45 percent of NCPACE participants have taken more than one course.

1. Dependent Variables

We constructed two models to address the questions in the previous chapter:

- We predicted a sailor's decision to attempt a subsequent course. For this model, the dependent variable is an indicator variable that equals 1 if a sailor attempts a second course and 0 if the sailor does not attempt a second course.
- We predicted a sailor's performance in a second course. For this model, the dependent variable is an indicator variable that equals 1 if a sailor completes the second course successfully and 0 if a sailor does not. This model is restricted to those who taken a second course.

2. Independent Variables

For the two models specified above, we considered the first course performance as an independent variable in addition to the variables we chose for the course completion model. The course performance variable equals 1 for successfully completed first courses and 0 for unsuccessful first courses. The model that evaluates a sailor's decision to take a subsequent course used course and sailor characteristics associated with the first course. The model that predicts performance in subsequent courses used course and sailor characteristics of the second course, with the exception of race, ethnicity, sex, and marital status (which are assumed to remain constant over time).

3. Model Assumptions, Model, and Model Diagnostics

To predict a sailor's decision to attempt a subsequent course, we assume *Attempt subsequent course_i* is a Bernoulli random variable with probability distribution as follows:

<i>Attempt subsequent course_i</i>	Probability
1	$P(\text{Attempt subsequent course}_i = 1) = \pi_i$
0	$P(\text{Attempt subsequent course}_i = 0) = 1 - \pi_i$

Table 5. Probability Distribution of *Attempt subsequent course_i*

We chose the logit transformation $\ln \frac{\pi}{1-\pi} = \beta_0 + \beta_{1i} \text{ Course subject}_i + \beta_{2i} \text{ Unit type}_i + \beta_{3i} \text{ Fiscal year}_i + \beta_{4i} \text{ School}_i + \beta_5 \text{ AFQT} + \beta_{6i} \text{ Education}_i + \beta_{7i} \text{ Rank}_i + \beta_{8i} \text{ Rating}_i + \beta_{9i} \text{ Race}_i + \beta_{10} \text{ Ethnicity} + \beta_{11} \text{ Sex} + \beta_{12} \text{ Successful completion of first course}$. We omitted *Course delivery method* and *Marital status* because the analysis of deviance table corresponding to the model containing these factors demonstrates that these factors are not statistically significant at the .05 level (Table 6).

	Df	Deviance	Resid. Df	Resid. Dev	Pr(Chi)
NULL			101000	139000	0
Technology	1	1.67	101000	139000	0.196
CourseType	4	108	101000	139000	0
UnitType	3	261	101000	139000	0
FY	13	2430	101000	136000	0
School	3	94.2	101000	136000	0
Afqt	1	296	101000	136000	0
Education	3	269	101000	135000	0
Rank	8	35.9	101000	135000	1.85E-05
Rating	4	21.6	101000	135000	0.000242
Race	5	199	101000	135000	0
Hispanic	1	56.5	101000	135000	5.6E-14
Female	1	143	101000	135000	0
Married	1	0.0874	101000	135000	0.767
Pass	1	3790	101000	131000	0

Table 6. Attempt Subsequent Course Model Analysis of Deviance Table

The Hosmer-Lemeshow test statistic has a p-value of 0.0413 (Chi-squared = 123.5834, df = 98), and Figure 20 is a plot of the observed versus expected values for the attempt subsequent course model. Although the p-value of the test statistic is smaller than .05, the plot indicates that the model “somewhat” fits the data. Figure 21 shows the ROC curve for the attempt subsequent course model. The AUC is 0.654 and all points lie above the chance line, indicating that the model predicts better than random guessing.

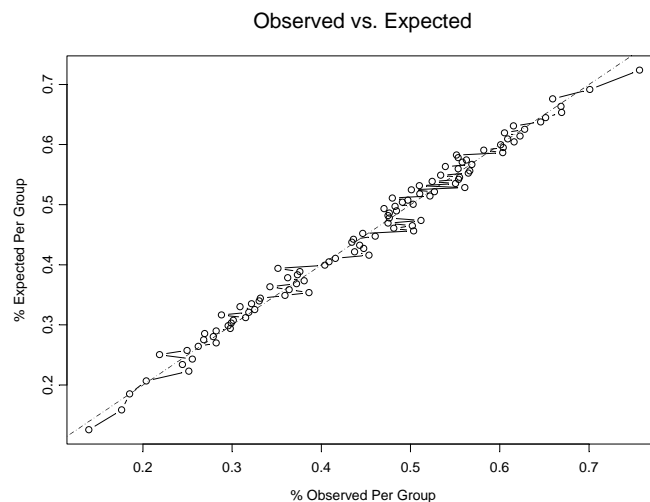


Figure 20. Hosmer-Lemeshow Plot of Attempt Subsequent Course Model

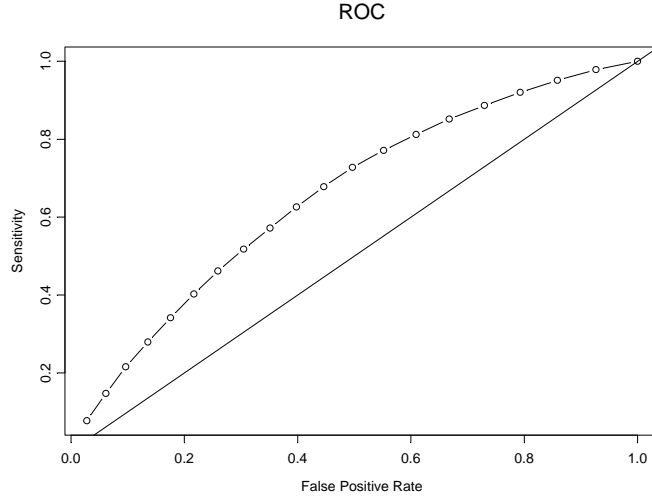


Figure 21. ROC Curve of Attempt Subsequent Course Model

To predict a sailor's performance in a subsequent course given that they decide to attempt a subsequent course, we assume *Complete subsequent course_i* is a Bernoulli random variable with probability distribution as follows:

<i>Complete subsequent course_i</i>	Probability
1	$P(\text{Complete subsequent course}_i = 1 \mid \text{Attempt subsequent course}_i = 1) = \pi_i$
0	$P(\text{Complete subsequent course}_i = 0 \mid \text{Attempt subsequent course}_i = 1) = 1 - \pi_i$

Table 7. Probability Distribution of *Complete subsequent course_i*

We used the logit transformation $\ln \frac{\pi}{1-\pi} = \beta_0 + \beta_1 \text{ Course delivery method} + \beta_{2i} \text{ Course subject}_i + \beta_{3i} \text{ Unit type}_i + \beta_{4i} \text{ Fiscal year}_i + \beta_{5i} \text{ School}_i + \beta_6 \text{ AFQT} + \beta_{7i} \text{ Education}_i + \beta_{8i} \text{ Rank}_i + \beta_{9i} \text{ Rating}_i + \beta_{10i} \text{ Race}_i + \beta_{11} \text{ Sex} + \beta_{12} \text{ Successful completion of first course}$. We omitted *Ethnicity* and *Marital status* because the analysis of deviance table corresponding to the model containing these factors demonstrates that these factors are not statistically significant at the .05 level (Table 8).

	Df	Deviance	Resid. Df	Resid. Dev	Pr(Chi)
NULL			101000	135000	0
Technology.subseqCourse	1	9550	101000	125000	0
Course.subseqCourse	4	686	101000	125000	0
UnitType.subseqCourse	3	742	101000	124000	0
FY.subseqCourse	13	1480	101000	122000	0
School.subseqCourse	3	603	101000	122000	0
Afqt.subseqCourse	1	1190	101000	121000	0
Education.subseqCourse	3	782	101000	120000	0
Rank.subseqCourse	8	3010	101000	117000	0
Rating.subseqCourse	4	36.6	101000	117000	0.000000218
Race	5	36.8	101000	117000	0.000000642
Hispanic	1	1.22	101000	117000	0.27
Female	1	33	101000	117000	9.34E-09
Married	1	1.77	101000	117000	0.183
Pass.firstCourse	1	45300	101000	71300	0

Table 8. Complete Subsequent Course Model Analysis of Deviance Table

The Hosmer-Lemeshow test statistic has a p-value of 0 (Chi-squared = 167.7942, df = 98), and Figure 22 is a plot of the observed versus expected values for the complete subsequent course model. Although the p-value of the test statistic is small, the plot indicates that the model fits the data “reasonably” well, though the mid-range observed values are slightly lower than the expected values.

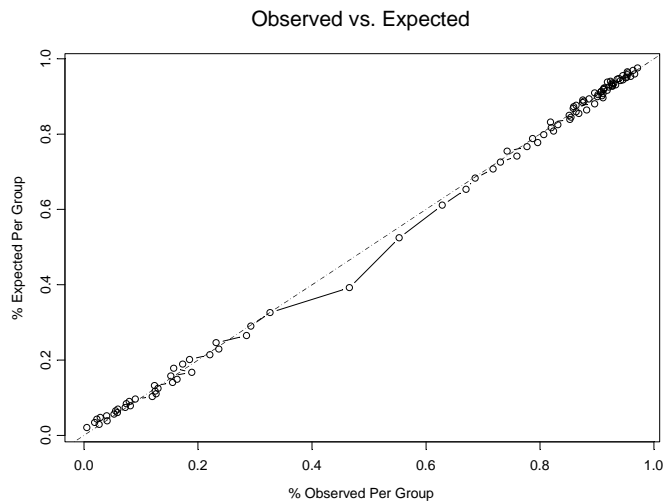


Figure 22. Hosmer-Lemeshow Plot of Complete Subsequent Course Model

Figure 23 shows the ROC curve for the complete subsequent course model. We have “outstanding” classification results, as the AUC is 0.906.

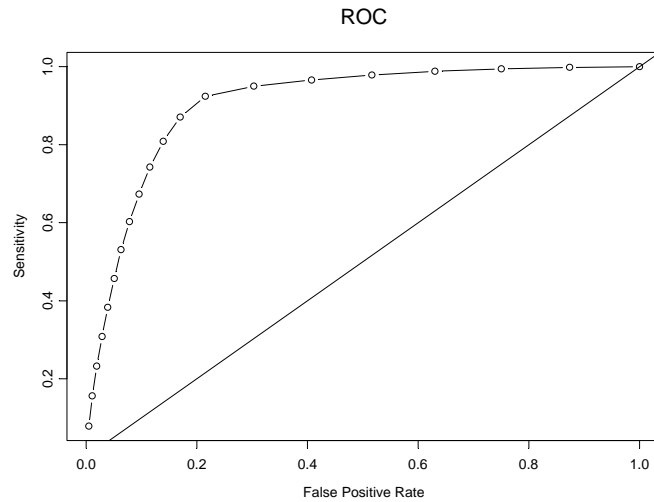


Figure 23. ROC Curve of Complete Subsequent Course Model

4. Analysis

The results of the attempt subsequent course model are presented in Table 9. We reject the null model in favor of this model, as our test statistic 7993.7 is greater than $\chi^2_{\alpha,47}$ for any reasonable choice for α . Passing the first course has the effect of multiplying the odds of completing the second course by 2.5.

	Value	Std. Error	t value	ChiSq	Pr(Chi)	Odds Ratio
(Intercept)	-0.334	0.145	-2.3	5.3	0.0213	0.716
CourseBus	-0.233	0.0232	-10	100	0	0.793
CourseMath	0.0589	0.0226	2.6	6.76	0.0093	1.06
CoursePSci	-0.0395	0.0306	-1.29	1.66	0.197	0.961
CourseOSci	-0.0426	0.0531	-0.803	0.644	0.422	0.958
UnitTypeOther	-0.129	0.0331	-3.89	15.1	0.0001	0.879
UnitTypeSubmarine	0.112	0.0387	2.89	8.33	0.0039	1.12
UnitTypeSurfaceCombat	0.0463	0.0293	1.58	2.5	0.114	1.05
FY1996	-0.532	0.122	-4.37	19.1	0	0.587
FY1997	-0.434	0.122	-3.56	12.7	0.0004	0.648
FY1998	-0.438	0.122	-3.58	12.8	0.0004	0.646
FY1999	-0.273	0.122	-2.24	5.02	0.0251	0.761
FY2000	-0.291	0.122	-2.39	5.71	0.0168	0.748
FY2001	-0.719	0.122	-5.9	34.8	0	0.487
FY2002	-0.743	0.123	-6.05	36.6	0	0.476
FY2003	-1.32	0.125	-10.6	111	0	0.266
FY2004	-0.801	0.125	-6.44	41.4	0	0.449
FY2005	-0.68	0.122	-5.57	31	0	0.507
FY2006	-0.808	0.122	-6.63	43.9	0	0.446
FY2007	-1.02	0.122	-8.3	69	0	0.362
FY2008	-1.7	0.124	-13.8	190	0	0.182
SchoolCoastline	0.284	0.0203	14	196	0	1.33
SchoolRichland	0.193	0.0292	6.62	43.8	0	1.21
SchoolOtherSchool	0.137	0.0266	5.14	26.4	0	1.15
Afqt	0.0039	0.0004	10.3	106	0	1
EdualtHS	-0.0762	0.0609	-1.25	1.56	0.211	0.927
EduHS	0.024	0.0535	0.448	0.201	0.654	1.02
EdusomeColl	0.247	0.057	4.34	18.8	0	1.28
RankE2	0.0211	0.0533	0.397	0.157	0.692	1.02
RankE3	-0.0972	0.0501	-1.94	3.76	0.0525	0.907
RankE4	-0.204	0.0504	-4.05	16.4	0.0001	0.815
RankE5	-0.221	0.0513	-4.3	18.5	0	0.802
RankE6	-0.185	0.0525	-3.52	12.4	0.0004	0.831
RankE7	-0.219	0.0576	-3.8	14.4	0.0002	0.803
RankE8	-0.206	0.0786	-2.62	6.88	0.0087	0.814
RankE9	-0.363	0.107	-3.4	11.5	0.0007	0.696
RatingFR	-0.143	0.0448	-3.19	10.2	0.0014	0.867
RatingIn	-0.0453	0.0391	-1.16	1.34	0.247	0.956
RatingMa	0.0493	0.0164	3.01	9.04	0.0026	1.05
RatingOp	0.0155	0.0244	0.637	0.406	0.524	1.02
RaceAIAN	-0.0557	0.0434	-1.28	1.64	0.2	0.946
RaceAsian	0.0583	0.0347	1.68	2.83	0.0927	1.06
RaceBlack	-0.143	0.0163	-8.75	76.6	0	0.867
RacePI	0.213	0.108	1.97	3.89	0.0485	1.24
RaceOtherRace	-0.279	0.0214	-13	170	0	0.757
Hispanic	0.138	0.0199	6.95	48.3	0	1.15
Female	0.197	0.0185	10.6	113	0	1.22
Pass	0.921	0.0153	60.2	3630	0	2.51
Null Deviance: 138953.1 on 101031 degrees of freedom Residual Deviance: 131259.4 on 100984 degrees of freedom 11412 observations deleted due to missing values						

Table 9. Attempt Subsequent Course Model Results

The results of the complete subsequent course model are presented in Table 10. We reject the null model in favor of this model, as our test statistic 63477.18 is greater than $\chi^2_{\alpha,47}$ for any reasonable choice for α . Passing the first course has the strongest effect on odds of completing the second course. We also found the following similarities to the first course completion model:

- Higher ranks have higher predicted success rates;
- Instructor-based courses have higher predicted success rates;
- Mathematics courses have lower predicted success rates;
- Submarine units had higher predicted success rates;
- Higher AFQT scores and levels of education were associated with higher predicted success rates; and
- Courses sponsored by Coastline Community College had higher predicted success rates.

	Value	Std. Error	t value	ChiSq	Pr(Chi)	Odds Ratio
(Intercept)	-1.73	0.229	-7.56	57.2	0	0.178
Technology.subCrs	-2.15	0.0868	-24.8	615	0	0.116
CourseBus.subCrs	0.124	0.0355	3.49	12.2	0.0005	1.13
CourseMath.subCrs	-0.587	0.0319	-18.4	339	0	0.556
CoursePSci.subCrs	0.0053	0.0432	0.122	0.0149	0.903	1.01
CourseOSci.subCrs	-0.174	0.0693	-2.51	6.32	0.0119	0.84
UnitTypeOther.subCrs	0.172	0.0495	3.47	12.1	0.0005	1.19
UnitTypeSubmarine.subCrs	0.438	0.0563	7.78	60.6	0	1.55
UnitTypeSurfaceCombat.subCrs	-0.0116	0.0443	-0.263	0.0689	0	0.988
FY1996.subCrs	-0.618	0.195	-3.17	10	0.0015	0.539
FY1997.subCrs	-0.741	0.194	-3.81	14.5	0.0001	0.477
FY1998.subCrs	-0.826	0.195	-4.24	17.9	0	0.438
FY1999.subCrs	-0.992	0.194	-5.11	26.1	0	0.371
FY2000.subCrs	-1.07	0.194	-5.53	30.6	0	0.343
FY2001.subCrs	-1	0.193	-5.17	26.8	0	0.368
FY2002.subCrs	-1.02	0.195	-5.23	27.4	0	0.361
FY2003.subCrs	-0.901	0.196	-4.59	21.1	0	0.406
FY2004.subCrs	-0.468	0.199	-2.35	5.51	0	0.627
FY2005.subCrs	-0.665	0.194	-3.43	11.7	0	0.515
FY2006.subCrs	-0.417	0.194	-2.15	4.63	0	0.659
FY2007.subCrs	-0.414	0.194	-2.14	4.57	0	0.661
FY2008.subCrs	-0.226	0.194	-1.17	1.36	0	0.797
SchoolCoastline.subCrs	0.72	0.0877	8.21	67.3	0	2.05
SchoolRichland.subCrs	-0.0014	0.0918	-0.0157	0.0003	0	0.999
SchoolOtherSchool.subCrs	0.261	0.0888	2.94	8.63	0	1.3
Afqt.subCrs.subCrs	0.007	0.0006	12.4	154	0	1.01
EdualtHS.subCrs	0.113	0.0891	1.27	1.61	0.204	1.12
EduHS.subCrs	0.208	0.0785	2.66	7.05	0	1.23
EdusomeColl.subCrs	0.507	0.0839	6.04	36.5	0	1.66
RankE2.subCrs	0.206	0.092	2.23	4.99	0.0255	1.23
RankE3.subCrs	0.343	0.0867	3.96	15.7	0.0001	1.41
RankE4.subCrs	0.579	0.0868	6.67	44.5	0	1.78
RankE5.subCrs	0.842	0.0879	9.58	91.9	0	2.32
RankE6.subCrs	1.08	0.0895	12	145	0	2.93
RankE7.subCrs	1.22	0.0958	12.8	163	0	3.4
RankE8.subCrs	1.35	0.124	10.9	119	0	3.85
RankE9.subCrs	1.43	0.165	8.68	75.4	0	4.19
RatingFR.subCrs	0.0874	0.0657	1.33	1.77	0.183	1.09
RatingIn.subCrs	0.173	0.0587	2.94	8.65	0.0033	1.19
RatingMa.subCrs	0.0163	0.0243	0.668	0.447	0.504	1.02
RatingOp.subCrs	0.0368	0.0356	1.03	1.07	0.302	1.04
RaceAIAN	0.0346	0.0642	0.539	0.291	0.59	1.04
RaceAsian	0.161	0.0522	3.08	9.5	0	1.17
RaceBlack	0.005	0.024	0.208	0.0433	0.835	1.01
RacePI	0.296	0.166	1.78	3.17	0	1.34
RaceOtherRace	0.0694	0.0314	2.21	4.89	0	1.07
Female	0.0243	0.0275	0.885	0.784	0	1.02
Pass.firstCourse	3.66	0.0207	177	31400	0	38.8
Null Deviance: 134818.8 on 101034 degrees of freedom Residual Deviance: 71341.62 on 100987 degrees of freedom 11409 observations deleted due to missing values						

Table 10. Complete Subsequent Course Model Results

C. PROMOTION MODEL

The goal of the promotion model is to determine if successfully completing NCPACE courses has an effect on promotion. This model considers promotions to E5 and is restricted to NCPACE participants with four-year contracts in their first term. We included 16,686 sailors who left before serving 36 months of their 48-month contract in the sample used for the promotion model.

1. Dependent Variable

The dependent variable for this model is an indicator variable that equals 1 if the sailor promoted to E5 by the end of their first term and 0 otherwise.

2. Independent Variables

The independent variables we chose are identical to the variables chosen for the Effects of First Course Results model with the course-specific variables omitted, an indicator variable added which captures if the participant succeeded an NCPACE course during their first term, and fiscal year indicator variables for the date of accession and separation.

3. Model Assumptions, Model, and Model Diagnostics

To predict a sailor's decision promotion to E5, we assume $Promoted_i$ is a Bernoulli random variable with probability distribution as follows:

$Promoted_i$	Probability
1	$P(Promoted_i = 1) = \pi_i$
0	$P(Promoted_i = 0) = 1 - \pi_i$

Table 11. Probability Distribution of $Promoted_i$

We used the logit transformation $\ln \frac{\pi}{1 - \pi} = \beta_0 + \beta_1 \text{Succeeded at least one NCPACE Course} + \beta_{2i} \text{Unit type}_i + \beta_{3i} \text{Fiscal year of first NCPACE course}_i + \beta_4 \text{AFQT} + \beta_{5i} \text{Education}_i + \beta_{6i} \text{Rank}_i + \beta_{7i} \text{Rating}_i + \beta_{8i} \text{Race}_i + \beta_9 \text{Marital status} + \beta_{10} \text{Fiscal Year of Accession} + \beta_{11} \text{Fiscal Year of Separation/Reenlistment}$. We omitted *Ethnicity* and

Sex because the analysis of deviance table corresponding to the model containing these factors demonstrates that these factors are not statistically significant at the .1 level (Table 12).

	Df	Deviance	Resid. Df	Resid. Dev	Pr(Chi)
NULL			41900	57800	0
NCPACESuccess	1	83.5	41900	57700	0
UnitType	3	839	41900	56900	0
FY	13	1190	41900	55700	0
Afqt	1	1890	41900	53800	0
Education	3	518	41800	53300	0
Rank	8	4400	41800	48900	0
Rating	4	610	41800	48300	0
Race	5	2420	41800	45900	0
Hispanic	1	1.31	41800	45900	0.253
Female	1	0.133	41800	45900	0.715
Married	1	7.54	41800	45900	0.00603
AccFY	9	982	41800	44900	0
SepReenFY	13	3770	41800	41100	0

Table 12. Promotion Model Analysis of Deviance Table

Although the Hosmer-Lemeshow test statistic has a p-value of 0 (Chi-squared = 210.6678, df = 98), the plot indicates that the model fits the data “reasonably” well (Figure 24).

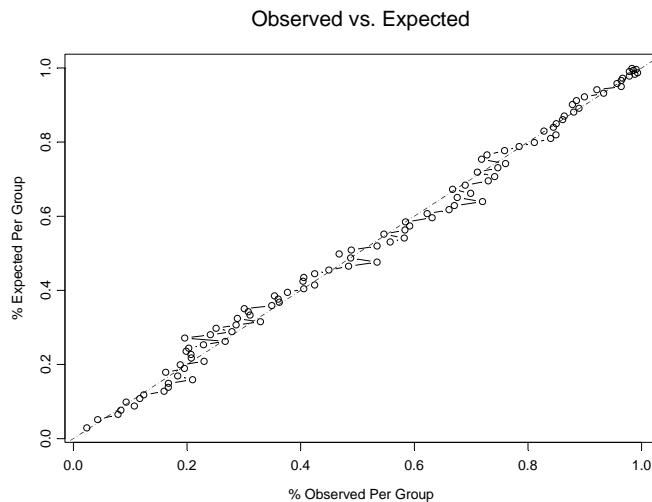


Figure 24. Hosmer-Lemeshow Plot of Promotion Model

Figure 25 shows the ROC curve for the promotion model. We have “excellent” classification results, as all points of the ROC are above the chance line and the AUC is 0.840.

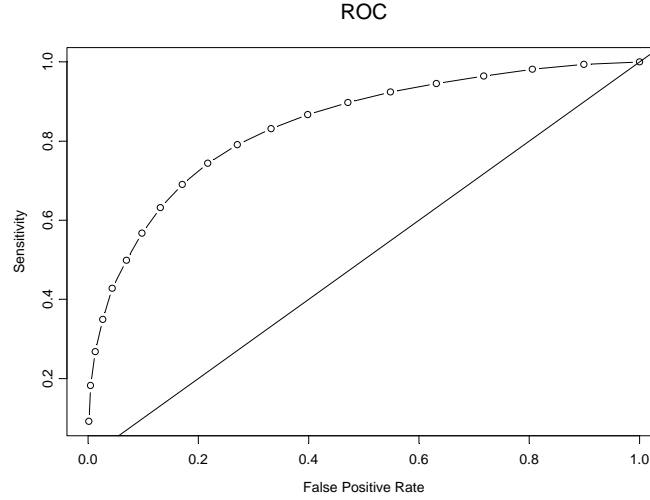


Figure 25. ROC Curve of Promotion Model

4. Analysis

The results of the promotion model are presented in Table 13. We reject the null model in favor of this model, as our test statistic 16713.14 is greater than $\chi^2_{\alpha,61}$ for any reasonable choice for α . We found that those who successfully completed at least once course are predicted to be more likely to promote to E5 by the end of their first term.

	Value	Std. Error	t value	ChiSq	Pr(Chi)	Odds Ratio
(Intercept)	2.83	0.786	3.6	12.9	0.0003	16.9
NCPACEsuccess	0.186	0.0261	7.15	51.1	0	1.2
UnitTypeOther	0.129	0.0577	2.24	5	0.0253	1.14
UnitTypeSubmarine	0.491	0.0759	6.46	41.8	0	1.63
UnitTypeSurfaceCombat	-0.0443	0.0495	-0.895	0.801	0.371	0.957
FY1996	-1.09	0.772	-1.41	1.99	0.158	0.336
FY1997	-1.62	0.768	-2.11	4.47	0.0345	0.197
FY1998	-1.94	0.769	-2.52	6.37	0.0116	0.144
FY1999	-2.39	0.77	-3.11	9.67	0.0019	0.0912
FY2000	-2.68	0.772	-3.48	12.1	0.0005	0.0683
FY2001	-3.09	0.773	-4	16	0.0001	0.0455
FY2002	-3.69	0.776	-4.76	22.6	0	0.0249
FY2003	-3.92	0.778	-5.04	25.4	0	0.0198
FY2004	-4.71	0.782	-6.02	36.3	0	0.009
FY2005	-4.83	0.782	-6.18	38.2	0	0.008
FY2006	-5.26	0.785	-6.7	44.9	0	0.0052
FY2007	-5.65	0.787	-7.17	51.4	0	0.0035

	Value	Std. Error	t value	ChiSq	Pr(Chi)	Odds Ratio
FY2008	-6.17	0.797	-7.74	59.9	0	0.0021
Afqt	0.012	0.0007	16.3	265	0	1.01
EducationaltHS	-0.237	0.102	-2.32	5.4	0.0202	0.789
EducationHS	0.0301	0.0908	0.331	0.11	0.74	1.03
EducationsomeColl	0.771	0.103	7.52	56.5	0	2.16
RankE2	0.256	0.077	3.33	11.1	0.0009	1.29
RankE3	0.59	0.0742	7.95	63.3	0	1.8
RankE4	1.71	0.0795	21.5	464	0	5.55
RankE5	5.06	0.137	37	1370	0	158
RankE6	1.57	0.359	4.38	19.2	0	4.82
RankE7	1.1	0.501	2.2	4.83	0.028	3
RankE8	0.751	0.671	1.12	1.25	0.263	2.12
RankE9	2.19	0.504	4.34	18.8	0	8.92
RatingFR	-0.51	0.132	-3.85	14.8	0.0001	0.601
RatingIn	0.979	0.0808	12.1	147	0	2.66
RatingMa	-0.198	0.0294	-6.74	45.5	0	0.82
RatingOp	0.813	0.0453	17.9	322	0	2.25
RaceAIAN	-0.172	0.0769	-2.23	4.99	0.0255	0.842
RaceAsian	0.011	0.0635	0.173	0.0301	0.862	1.01
RaceBlack	-1.19	0.0314	-38	1450	0	0.303
RacePI	-0.151	0.197	-0.764	0.584	0.445	0.86
RaceOtherRace	-1.59	0.0398	-39.8	1590	0	0.205
Married	0.126	0.0322	3.9	15.2	0.0001	1.13
AccFY1996	1.07	0.0784	13.6	186	0	2.91
AccFY1997	1.65	0.0857	19.2	371	0	5.21
AccFY1998	2.16	0.0988	21.9	480	0	8.71
AccFY1999	2.08	0.11	18.9	357	0	8.03
AccFY2000	1.78	0.125	14.3	203	0	5.92
AccFY2001	1.45	0.141	10.3	107	0	4.28
AccFY2002	1.02	0.155	6.54	42.7	0	2.76
AccFY2003	0.627	0.165	3.8	14.4	0.0002	1.87
AccFY2004	0.0324	0.175	0.185	0.034	0.854	1.03
SepReenFY1996	-4.55	0.281	-16.2	263	0	0.0105
SepReenFY1997	-4.51	0.251	-18	324	0	0.011
SepReenFY1998	-4.21	0.183	-23.1	531	0	0.0148
SepReenFY1999	-3.42	0.126	-27.1	737	0	0.0327
SepReenFY2000	-3.32	0.12	-27.6	764	0	0.036
SepReenFY2001	-2.96	0.113	-26.3	690	0	0.0517
SepReenFY2002	-2.87	0.11	-26.1	681	0	0.0568
SepReenFY2003	-2.3	0.105	-21.9	482	0	0.101
SepReenFY2004	-3.55	0.109	-32.6	1060	0	0.0287
SepReenFY2005	-2.92	0.105	-27.8	775	0	0.0539
SepReenFY2006	-1.2	0.0972	-12.3	152	0	0.302
SepReenFY2007	-0.531	0.0955	-5.56	30.9	0	0.588
SepReenFY2008	0.221	0.102	2.16	4.66	0.0309	1.25
Null Deviance: 57814.77 on 41870 degrees of freedom Residual Deviance: 41101.63 on 41809 degrees of freedom 5535 observations deleted due to missing values						

Table 13. Promotion Model Results

In light of Buddin and Kapur's study, we examined the independent variable *Succeeded at least one NCPACE Course* in our model to see if it is sensitive to sailors who attrite early. We reran the regression with a sample that excluded those who left before serving 36 months of their 48-month contract. The resulting p-value of this

variable with the modified sample was 0.04, with a coefficient of .094 (odds ratio of 1.09). The promotion effects in the model without early separators are slightly smaller.

D. RETENTION MODELS

The objective of the extension and reenlistment models are to determine if success in NCPACE affects a first term sailor's decision to extend their contract beyond its original term of 48 months. Like the promotion model, the retention models were restricted to NCPACE participants with four-year contracts in their first term and included sailors who left before serving 36 months of their 48-month contract.

1. Dependent Variable

The dependent variable for the extension model is an indicator variable which equals 1 if the sailor is still serving after 48 months of service and 0 if the sailor did not.

The dependent variable for the reenlistment model is an indicator variable which equals 1 if the sailor has a reenlistment action on record after accessing 0 if the sailor does not.

2. Independent Variables

The independent variables we chose are identical to the variables chosen for the promotion model.

3. Model Assumptions, Model, and Model Diagnostics

To predict a sailor's decision to reenlist, we assume $Reenlist_i$ is a Bernoulli random variable with probability distribution as follows:

$Reenlist_i$	Probability
1	$P(Reenlist_i = 1) = \pi_i$
0	$P(Reenlist_i = 0) = 1 - \pi_i$

Table 14. Probability Distribution of $Reenlist_i$

For the extension model, we used the logit transformation $\ln \frac{\pi}{1-\pi} = \beta_0 + \beta_1$ *Succeeded at least one NCPACE Course* + β_{2i} *Unit type_i* + β_{3i} *Fiscal year of first NCPACE course_i* + β_4 *AFQT* + β_{5i} *Education_i* + β_{6i} *Rank_i* + β_{7i} *Rating_i* + β_{8i} *Race_i* + β_9 *Ethnicity* + β_{10} *Sex* + β_{11} *Marital status* + β_{12} *Fiscal Year of Accession* + β_{13} *Fiscal Year of Separation*. The analysis of deviance table corresponding to the course completion model demonstrates that the selected factors are statistically significant at the .05 level (Table 15).

	Df	Deviance	Resid. Df	Resid. Dev	Pr(Chi)
NULL			41900	55100	0
NCPACEsuccess	1	4.88	41900	55100	0.0272
UnitType	3	211	41900	54900	0
FY	13	14200	41900	40700	0
Afqt	1	418	41900	40300	0
Education	3	319	41800	40000	0
Rank	8	3060	41800	36900	0
Rating	4	79	41800	36800	3.33E-16
Race	5	2010	41800	34800	0
Hispanic	1	8.17	41800	34800	0.00426
Female	1	49.3	41800	34800	2.15E-12
Married	1	42.3	41800	34700	7.98E-11
AccFY	9	1950	41800	32800	0
SepReenFY	13	3350	41800	29400	0

Table 15. Extension Model Analysis of Deviance Table

The Hosmer-Lemeshow test statistic has a p-value of 0 (Chi-squared = 950.4458, df = 98), and Figure 26 is a plot of the observed versus expected values for the extension model. The plot shows that the model “somewhat” fits the data, though mid-range observed values are slightly higher than the expected values and the upper-range observed values are slightly lower than the expected values.

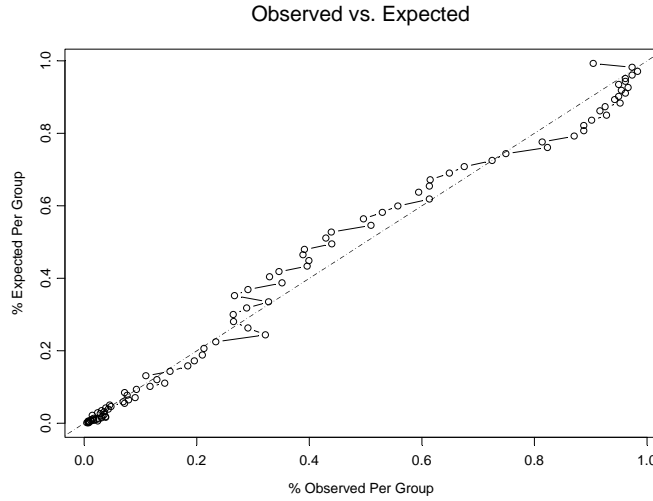


Figure 26. Hosmer-Lemeshow Plot of Extension Model

Figure 27 shows the ROC curve for the extension model. We have “outstanding” classification results, as all points of the ROC are above the chance line and the AUC is 0.917.

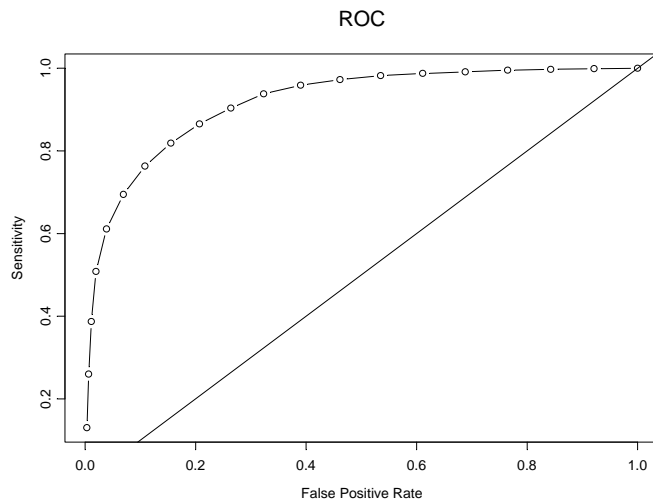


Figure 27. ROC Curve of Extension Model

For the reenlistment model, we used the logit transformation $\ln \frac{P}{1-P} = \beta_0 + \beta_1$
Succeeded at least one NCPACE Course + β_{2i} *Unit type*_i + β_{3i} *Fiscal year of first*
*NCPACE course*_i + β_{5i} *Education*_i + β_{6i} *Rank*_i + β_{7i} *Rating*_i + β_{8i} *Race*_i + β_{10} *Sex* + β_{11}

Marital status + β_{12} *Fiscal Year of Accession* + β_{13} *Fiscal Year of Separation*. We omitted *Afqt* and *Ethnicity* because the analysis of deviance table corresponding to the model containing these factors demonstrates that these factors are not statistically significant at the .05 level (Table 16).

	Df	Deviance	Resid. Df	Resid. Dev	Pr(Chi)
NULL			41900	50200	0
NCPACESuccess	1	16.9	41900	50200	3.98E-05
UnitType	3	303	41900	49900	0
FY	13	3270	41900	46600	0
Afqt	1	1.4	41900	46600	0.237
Education	3	450	41800	46200	0
Rank	8	1410	41800	44800	0
Rating	4	14.5	41800	44800	0.00592
Race	5	3060	41800	41700	0
Hispanic	1	0.122	41800	41700	0.727
Female	1	15.1	41800	41700	0.000104
Married	1	157	41800	41500	0
AccFY	9	1880	41800	39600	0
SepReenFY	13	7730	41800	31900	0

Table 16. Reenlistment Model Analysis of Deviance Table

The Hosmer-Lemeshow test statistic has a p-value of 0 (Chi-squared = 1313.531, df = 98), and Figure 28 is a plot of the observed versus expected values for the reenlistment model. The plot reveals some systematic under- and over-predicting.

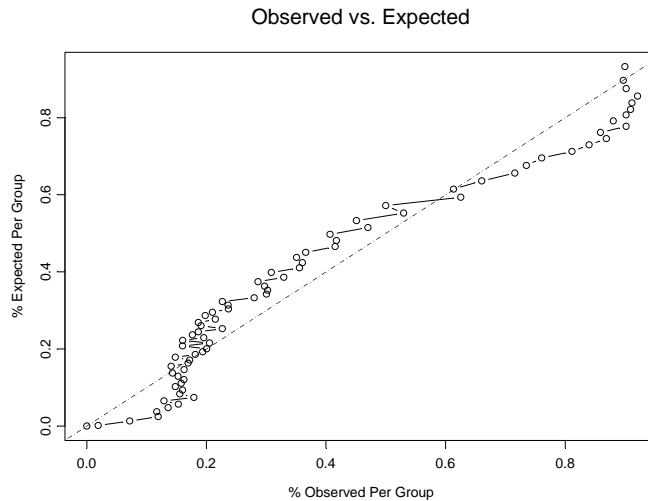


Figure 28. Hosmer-Lemeshow Plot of Reenlistment Model

Figure 29 shows the ROC curve for the reenlistment model. We have “excellent” classification results, as all points of the ROC are above the chance line and the AUC is 0.876.

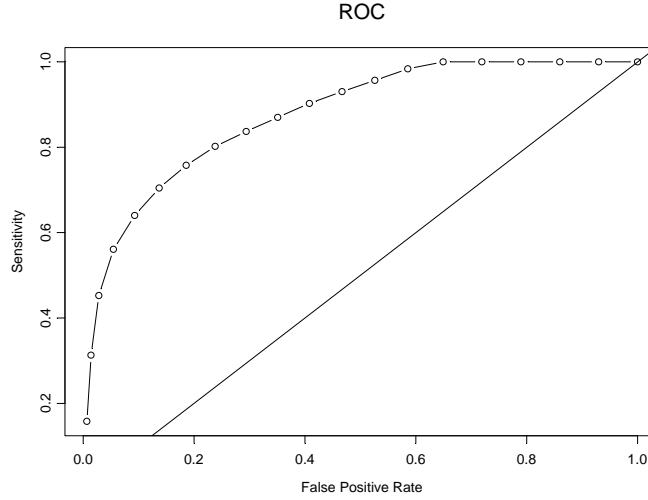


Figure 29. ROC Curve of Reenlistment Model

4. Analysis

The results of the extension model are presented in Table 17. We reject the null model in favor of this model, as our test statistic 25699.82 is greater than $\chi^2_{\alpha,63}$ for any reasonable choice for α . We found that completing at least once course does not have a statistically significant effect on extending, as the p-value associated with this factor exceeds any reasonable cutoff.

	Value	Std. Error	t value	ChiSq	Pr(Chi)	Odds Ratio
(Intercept)	5.4	0.974	5.55	30.8	0	222
NCPACESuccess	-0.0112	0.0312	-0.359	0.129	0.72	0.989
UnitTypeOther	-0.204	0.0678	-3.01	9.06	0.0026	0.815
UnitTypeSubmarine	0.0819	0.0854	0.959	0.92	0.337	1.09
UnitTypeSurfaceCombat	-0.104	0.0568	-1.83	3.35	0.0671	0.901
FY1996	0.734	0.955	0.769	0.591	0.442	2.08
FY1997	0.698	0.953	0.733	0.537	0.464	2.01
FY1998	0.864	0.954	0.906	0.821	0.365	2.37
FY1999	0.932	0.955	0.976	0.953	0.329	2.54
FY2000	1.07	0.956	1.12	1.26	0.263	2.92
FY2001	0.807	0.958	0.843	0.711	0.399	2.24
FY2002	0.424	0.96	0.442	0.195	0.659	1.53
FY2003	0.218	0.962	0.227	0.0513	0.821	1.24
FY2004	-0.285	0.966	-0.295	0.0871	0.768	0.752
FY2005	-0.617	0.968	-0.638	0.407	0.524	0.54

	Value	Std. Error	t value	ChiSq	Pr(Chi)	Odds Ratio
FY2006	-1.03	0.975	-1.06	1.13	0.289	0.355
FY2007	-1.34	0.994	-1.35	1.81	0.178	0.262
FY2008	-1.67	1.15	-1.45	2.11	0.146	0.189
Afqt	-0.0021	0.0009	-2.35	5.51	0.0189	0.998
EducationaltHS	0.0004	0.122	0.0029	0	0.998	1
EducationHS	-0.027	0.109	-0.247	0.0611	0.805	0.973
EducationSomeColl	0.604	0.121	4.98	24.8	0	1.83
RankE2	0.0043	0.0909	0.0468	0.0022	0.963	1
RankE3	0.223	0.0875	2.55	6.49	0.0108	1.25
RankE4	0.946	0.0931	10.2	103	0	2.58
RankE5	1.51	0.11	13.8	190	0	4.54
RankE6	1.15	0.388	2.98	8.88	0.0029	3.17
RankE7	0.326	0.544	0.598	0.358	0.55	1.38
RankE8	0.817	0.657	1.24	1.54	0.214	2.26
RankE9	2.31	0.805	2.86	8.2	0.0042	10
RatingFR	0.191	0.195	0.983	0.967	0.326	1.21
RatingIn	-0.527	0.0893	-5.9	34.9	0	0.59
RatingMa	-0.0725	0.0362	-2	4.02	0.045	0.93
RatingOp	-0.274	0.0517	-5.29	28	0	0.761
RaceAIAN	-0.0199	0.109	-0.183	0.0333	0.855	0.98
RaceAsian	0.179	0.084	2.14	4.56	0.0328	1.2
RaceBlack	-1.54	0.041	-37.7	1420	0	0.213
RacePI	0.46	0.415	1.11	1.23	0.268	1.58
RaceOtherRace	-1.82	0.0479	-38	1450	0	0.162
Hispanic	0.0874	0.0424	2.06	4.25	0.0393	1.09
Female	0.297	0.0396	7.49	56.1	0	1.35
Married	0.295	0.0412	7.16	51.3	0	1.34
AccFY1996	-0.573	0.0837	-6.84	46.8	0	0.564
AccFY1997	-1.37	0.097	-14.2	201	0	0.253
AccFY1998	-1.88	0.113	-16.6	275	0	0.152
AccFY1999	-3.56	0.13	-27.4	750	0	0.0285
AccFY2000	-5.79	0.148	-39.1	1530	0	0.0031
AccFY2001	-6.3	0.165	-38.1	1450	0	0.0018
AccFY2002	-7.29	0.188	-38.8	1510	0	0.0007
AccFY2003	-8.09	0.213	-37.9	1440	0	0.0003
AccFY2004	-9.67	0.275	-35.2	1240	0	0.0001
SepReenFY1996	-5.78	0.25	-23.1	534	0	0.0031
SepReenFY1997	-5.52	0.219	-25.2	635	0	0.004
SepReenFY1998	-5.7	0.186	-30.7	940	0	0.0033
SepReenFY1999	-5.3	0.143	-37.2	1380	0	0.005
SepReenFY2000	-4.44	0.133	-33.4	1110	0	0.0117
SepReenFY2001	-3.39	0.123	-27.6	762	0	0.0336
SepReenFY2002	-2.74	0.117	-23.4	546	0	0.0648
SepReenFY2003	-1.48	0.105	-14	197	0	0.229
SepReenFY2004	-2.36	0.113	-20.9	439	0	0.0942
SepReenFY2005	-2.28	0.116	-19.6	386	0	0.102
SepReenFY2006	-0.878	0.097	-9.06	82	0	0.416
SepReenFY2007	-0.492	0.0981	-5.01	25.1	0	0.612
SepReenFY2008	0.148	0.101	1.47	2.15	0.143	1.16
Null Deviance: 55134.94 on 41870 degrees of freedom Residual Deviance: 29435.12 on 41807 degrees of freedom 5535 observations deleted due to missing values						

Table 17. Extension Model Results

The results of the reenlistment model are presented in Table 18. We reject the null model in favor of this model, as our test statistic 18459.6 is greater than $\chi^2_{\alpha,61}$ for any reasonable choice for α . We found that those who successfully completed at least once course are predicted to be slightly less likely to reenlist in the Navy.

	Value	Std. Error	t value	ChiSq	Pr(Chi)	Odds Ratio
(Intercept)	-16.6	61.4	-0.271	0.0733	0.787	0
NCPACEsuccess	-0.0825	0.0272	-3.03	9.2	0.00241	0.921
UnitTypeOther	-0.18	0.0598	-3.01	9.03	0.00265	0.836
UnitTypeSubmarine	0.367	0.0728	5.05	25.5	0	1.44
UnitTypeSurfaceCombat	-0.145	0.0512	-2.83	8.03	0.00459	0.865
FY1996	0.698	1.1	0.632	0.4	0.527	2.01
FY1997	0.556	1.1	0.505	0.255	0.614	1.74
FY1998	0.619	1.1	0.562	0.315	0.574	1.86
FY1999	0.698	1.1	0.633	0.401	0.527	2.01
FY2000	0.794	1.1	0.72	0.518	0.472	2.21
FY2001	0.835	1.1	0.756	0.571	0.45	2.3
FY2002	0.626	1.11	0.566	0.32	0.571	1.87
FY2003	0.668	1.11	0.603	0.363	0.547	1.95
FY2004	0.364	1.11	0.328	0.108	0.743	1.44
FY2005	0.226	1.11	0.203	0.0412	0.839	1.25
FY2006	0.423	1.11	0.38	0.144	0.704	1.53
FY2007	0.459	1.12	0.411	0.169	0.681	1.58
FY2008	1.69	1.23	1.38	1.91	0.167	5.44
EducationaltHS	-0.132	0.101	-1.3	1.68	0.195	0.877
EducationHS	-0.0437	0.0887	-0.492	0.242	0.623	0.957
EducationsomeColl	0.864	0.099	8.73	76.2	0	2.37
RankE2	0.0636	0.0848	0.75	0.563	0.453	1.07
RankE3	0.164	0.0813	2.02	4.09	0.0432	1.18
RankE4	0.541	0.0853	6.34	40.2	0	1.72
RankE5	0.936	0.0967	9.68	93.7	0	2.55
RankE6	0.526	0.348	1.51	2.28	0.131	1.69
RankE7	0.478	0.493	0.969	0.938	0.333	1.61
RankE8	0.526	0.531	0.99	0.981	0.322	1.69
RankE9	0.948	0.427	2.22	4.92	0.0265	2.58
RatingFR	-0.0475	0.147	-0.322	0.104	0.747	0.954
RatingIn	-0.118	0.0757	-1.56	2.45	0.118	0.888
RatingMa	-0.283	0.0313	-9.05	81.9	0	0.753
RatingOp	-0.2	0.0455	-4.39	19.3	0.00001	0.819
RaceAIAN	-0.0528	0.0866	-0.61	0.373	0.542	0.949
RaceAsian	0.194	0.0669	2.9	8.4	0.00376	1.21
RaceBlack	-1.43	0.0316	-45.4	2060	0	0.238
RacePI	0.125	0.281	0.446	0.199	0.656	1.13
RaceOtherRace	-2.18	0.0424	-51.4	2640	0	0.113
Female	0.187	0.0341	5.5	30.2	0	1.21
Married	0.425	0.0335	12.7	161	0	1.53
AccFY1996	-0.0908	0.0711	-1.28	1.63	0.201	0.913
AccFY1997	-0.107	0.0773	-1.38	1.91	0.167	0.899
AccFY1998	0.117	0.0894	1.31	1.72	0.19	1.12
AccFY1999	-0.186	0.101	-1.83	3.36	0.067	0.83
AccFY2000	-0.608	0.12	-5.08	25.8	0	0.544
AccFY2001	-0.501	0.138	-3.63	13.1	0.00029	0.606
AccFY2002	-0.367	0.152	-2.42	5.85	0.0156	0.693
AccFY2003	-0.839	0.166	-5.05	25.5	0	0.432
AccFY2004	-1.37	0.202	-6.81	46.4	0	0.253
SepReenFY1996	0.431	188	0.00229	0.00001	0.998	1.54
SepReenFY1997	14.6	61.4	0.238	0.0567	0.812	2210000

	Value	Std. Error	t value	ChiSq	Pr(Chi)	Odds Ratio
SepReenFY1998	15.5	61.4	0.253	0.0641	0.8	5610000
SepReenFY1999	15.9	61.4	0.259	0.0672	0.795	8160000
SepReenFY2000	16.5	61.4	0.268	0.0721	0.788	14400000
SepReenFY2001	16.7	61.4	0.271	0.0737	0.786	17200000
SepReenFY2002	16.5	61.4	0.269	0.0726	0.788	15200000
SepReenFY2003	16.9	61.4	0.275	0.0755	0.784	21100000
SepReenFY2004	0.0462	74.1	0.00062	0	1	1.05
SepReenFY2005	13.7	61.4	0.223	0.0496	0.824	867000
SepReenFY2006	16.6	61.4	0.27	0.0728	0.787	15600000
SepReenFY2007	15.8	61.4	0.257	0.0661	0.797	7110000
SepReenFY2008	0.528	66.6	0.00793	0.00006	0.994	1.7
Null Deviance: 55681.5 on 47143 degrees of freedom Residual Deviance: 37221.9 on 47082 degrees of freedom 262 observations deleted due to missing values						

Table 18. Reenlistment Model Results

In a manner similar to the promotion model, we examined the independent variable *Succeeded at least one NCPACE Course* in the reenlistment model to see if it is sensitive to sailors who attrite before they are able to make a decision to reenlist. We reran the regression with a sample that excluded those who left before serving 36 months of their 48-month contract. The resulting p-value of this variable with the modified sample was 0, with a coefficient of -.141 (odds ratio of .868). The negative reenlistment effects in the model without early separators are slightly larger.

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IV. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

1. Factors Associated with Successful NCPACE Course Completions

We evaluated the likelihood of successful first course completions by course and sailor attributes. The descriptive statistics and multivariate analysis demonstrated the following:

- Instructor-based courses have higher predicted success rates. We found that participants who take Instructor PACE courses were about ten times more likely to succeed than those taking Technology PACE courses.
- Success rates also vary across course subjects. Mathematics courses had the lowest predicted success rates.
- AFQT scores and levels of education were associated with higher predicted success rates. Participants who have taken some college courses were twice as likely to succeed compared to those who did not finish high school.
- Higher ranked sailors succeeded at higher rates than lower ranked sailors. E4s were twice as likely to successfully complete their first course compared to E1s. E6s were about three times more likely to complete compared to E1s.
- There is some variance in success by unit type. Submarine units have higher predicted success rates.
- Courses sponsored by Coastline Community College have higher predicted success rates.

2. Impact of First Course Results

We found that the successful completion of the first course is positively associated with enrollments in subsequent courses and a factor in successfully completing

subsequent ones. Successfully completing the first course had the biggest effect on both the odds of attempting a subsequent course and successfully completing the subsequent course. We also found that the independent variables which explained first course completions also explain subsequent course completions.

3. Impact of Successful NCPACE Course Completions on Promotion and Retention

We evaluated promotion, extension and reenlistment outcomes for first-term NCPACE participants with 48-month contracts. We found that those who successfully completed at least once course are predicted to be more likely to promote to E5 by the end of their first term, even after controlling for factors such as rating.

We found that completing at least once course does not have a statistically significant effect on extensions. However, those who successfully completed at least once course are predicted to be slightly less likely to reenlist in the Navy.

B. RECOMMENDATIONS

Throughout this thesis, we have identified factors that are associated with successfully completing the first NCPACE course and attempting and completing subsequent courses. We recommend using this information as a basis for creating targeted screening guidelines and tailoring academic counseling efforts.

NCPACE policies and guidelines continually emphasize the role of academic counseling and command leadership in ensuring that participants succeed in the program. While the data we were able to obtain explained some of the variance in course performance, we were not able to measure the effectiveness of academic counseling and command support. We recommend that NCPACE collect, store, and make available the following data for future evaluations of the effectiveness of the program:

- pre-NCPACE assessment test scores
- the participant's education plan status at the time of the course including:
 - whether the participant has agreed to an education plan

- whether the course taken fulfills a requirement for a degree
- degree completion information
- exit survey data after each course to capture the following qualitative factors:
 - level of support offered by the command leadership
 - perceived quality of instructor and course materials support
 - reason for completing or withdrawing.

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